BS 4250:2014

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Specification for commercial butane and commercial propane

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Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 12, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 November 2014. It was prepared by Technical Committee PTI/15, *Natural gas and gas analysis*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 4250:1997, which is withdrawn.

Information about this document

The changes in this edition of BS 4250 are intended to align, wherever possible, the requirements of this standard with BS EN 589:2008+A1:2012 to reflect the situation that some UK refineries manufacture liquefied petroleum gas (LPG) to meet both standards. A number of test methods required by the previous edition of this standard have now been withdrawn, so these have been replaced by up-to-date test methods. Annex A has been updated to align with BS EN 589:2008+A1:2012, Annex C, including the alignment of gauge vapour pressure factors. Flammability limits have been updated in line with latest guidance.

This British Standard calls for the use of substances and/or procedures that might be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage. Attention is drawn to the safety warnings given in the introduction to this standard.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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

Introduction

SAFETY WARNINGS. Attention is drawn to the risk of fire and explosion when handling commercial butane or commercial propane, and to the hazard to health which arises through inhalation of excessive amounts of commercial butane or commercial propane.

Commercial butane and commercial propane are highly volatile hydrocarbon liquids which are normally stored under pressure. If the pressure is released, large volumes of gas are produced which form flammable mixtures with air. For *n*-butane this is typically over the range 1.4% (v/v) to 9.4% (v/v), and for propane this is typically over the range 1.7% (v/v) to 10.8% (v/v). The procedures described in this British Standard involve the sampling, handling and testing of commercial butane or commercial propane. All such procedures should be conducted away from sources of ignition such as naked flames, unprotected electrical equipment and electrostatic hazards. Testing should be performed as far as practicable under an electrically-safe ventilation hood.

NOTE 1 The lower flammability limits for propane and n-butane are aligned with BS EN ISO 10156. The upper flammability limits for propane and n-butane are aligned with the latest European Industrial Gases Association (EIGA) [1)] *guidance at the time of publication of this standard.*

Commercial butane or commercial propane in liquid form can cause cold burns to the skin. Protective clothing such as gloves and goggles should be worn if contact with the skin is likely to occur.

Unnecessary inhalation of commercial butane or commercial propane vapour should be avoided. The operator should not be exposed to atmospheres containing more than 1 000 ppm (1 750 mg/m^3) over an 8 h time-weighted average reference period (long-term exposure limit), or greater than 1 250 ppm (2 180 mg/m^3) over a 15 min reference period (short-term exposure limit). One of the tests described in this standard involves the operator inhaling a mixture of air and commercial butane or commercial propane vapour, and particular attention is drawn to the cautionary statement in **5.3**.

NOTE 2 These exposure limits are taken from HSE publication EH 40/2005 [1]. The workplace exposure limits given in the latest edition should be observed.

[1)] See <https://www.eiga.eu> [last viewed 24 November 2014].

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1 Scope

This British Standard specifies requirements for commercial butane and commercial propane as supplied for general domestic and industrial fuel purposes. It applies to these products in cylinders and in bulk.

NOTE 1 The requirements apply at the point of custody transfer. Withdrawal or loss of product from the vapour phase changes the composition of the product remaining in the liquid phase. Hence the product might then cease to meet specified requirements.

It does not cover gases for testing gas appliances.

NOTE 2 For gases to test gas appliances, see BS EN 437.

2 Normative references

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

ASTM D2163, *Standard test method for determination of hydrocarbons in liquefied petroleum (LP) gases and propane/propene mixtures by gas chromatography*

ASTM D3246, *Standard test method for sulfur in petroleum gas by oxidative microcoulometry*

ASTM D6667, *Standard test method for determination of total volatile sulfur in gaseous hydrocarbons and liquefied petroleum gases by ultraviolet fluorescence*

BS 2000-272, *Methods of test for petroleum and its products – Determination of mercaptan sulfur and hydrogen sulfide content of liquefied petroleum gases (LPG) – Electrometric titration method*

BS 2000-317, *Methods of test for petroleum and its products – Determination of residues in liquefied petroleum gases – Low temperature evaporation method*

BS EN 1439, *LPG equipment and accessories – Procedure for checking LPG cylinders before, during and after filling*

BS EN 13096, *Transportable gas cylinders – Conditions for filling gases into receptacles – Single component gases*

BS EN 15469, *Petroleum products – Test method for free water in liquefied petroleum gas by visual inspection*

BS EN 27941, *Methods of test for petroleum and its products – Commercial propane and butane – Analysis by gas chromatography*

BS EN ISO 3696:1995, *Water for analytical laboratory use – Specification and test methods*

BS EN ISO 4256, *Liquid petroleum products – Determination of gauge vapour pressure – LPG method*

BS EN ISO 4257, *Methods of test for petroleum and its products – Liquefied petroleum gases – Method of sampling*

BS EN ISO 4259, *Petroleum products – Determination and application of precision data in relation to methods of test*

BS EN ISO 6251, *Liquefied petroleum gases – Corrosiveness to copper – Copper strip test*

BS EN ISO 13758, *Methods of test for petroleum and its products – Liquefied petroleum gases – Assessment of the dryness of propane – Valve freeze method*

3 Sampling

For all test methods, sampling shall be carried out from the liquid phase in accordance with the procedures described for liquefied gases in BS EN ISO 4257.

NOTE The method described in ASTM D3700 may be used, subject to agreement between supplier and customer.

WARNING. Attention is drawn to the need to observe relevant safety precautions for handling commercial butane or commercial propane during sampling operations.

4 Composition

4.1 Commercial butane

The product shall consist of a hydrocarbon mixture containing predominantly butanes and/or butenes.

*NOTE Commercial butane as defined in this British Standard meets the requirement of ADR, the European Agreement concerning the carriage of dangerous goods by road. Commercial butane is defined as a pure gas in accordance with ADR [2] definition Note 2 in Section **2.2.2.3** and can therefore be assigned to UN Number 1011.*

4.2 Commercial propane

The product shall consist of a hydrocarbon mixture containing predominantly propane and/or propene.

*NOTE Commercial propane as defined in this British Standard meets the requirement of ADR, the European Agreement concerning the carriage of dangerous goods by road. Commercial propane is defined as a pure gas in accordance with ADR [2] definition Note 2 in Section **2.2.2.3** and can therefore be assigned to UN Number 1978.*

5 Properties of commercial butane and commercial propane

5.1 General

The properties of the commercial butane and commercial propane shall be in accordance with Table 1.

For gauge vapour pressure, either the direct measurement method described in BS EN ISO 4256 or the calculation procedure described in Annex A of this standard shall be used. The method described in BS EN ISO 4256 is the reference method and shall be used in cases of dispute.

5.2 Water content

Commercial butane and commercial propane shall not contain free or suspended water at 0 °C and at the saturated vapour pressure on visual inspection. Additionally, for commercial propane, the content of dissolved water shall not be such as to cause failure when tested in accordance with the valve freeze method described in BS EN ISO 13758.

NOTE For operational purposes, it is allowed to add up to 2 000 mg/kg methanol. No other antifreeze agents should be added.

5.3 Odour

When tested in accordance with the procedure described in Annex B, the odour of the gas shall be in accordance with Table 1.

NOTE 1 Odorants such as ethanethiol, tetrahydrothiophene or dimethyl sulfide may be added so that the gas conforms to this requirement, provided that the product is still in accordance with Table 1.

NOTE 2 If ethanethiol (ethyl mercaptan) is added as an odorant, it may be assumed that the commercial butane or commercial propane conforms to the above odour requirements, provided that the content of ethanethiol in the liquid phase is not less than 14 cm^3/m^3.

NOTE 3 If tetrahydrothiophene is added as an odorant, a higher concentration than that for ethanethiol is required because of the lower olfactory response of tetrahydrothiophene. It may be assumed that the commercial butane or commercial propane conforms to the above odour requirements, provided that the content of tetrahydrothiophene in the liquid phase is not less than 77 cm^3/m^3.

WARNING. In order to minimize the exposure of personnel conducting the odour test, it is strongly recommended that the test should only be performed when it has been ascertained that commercial butane or commercial propane already meets the other specification limits detailed in Table 1. The test involves the operator inhaling a mixture of commercial butane or commercial propane vapour and air. There is a risk that the short-term and/or long-term (8 h TWA reference period) occupational exposure limits for substances contained in the commercial butane or commercial propane might be exceeded. The operator should consult relevant safety and health regulations and ensure that exposure during the sampling, handling and testing of commercial butane or commercial propane does not exceed the prescribed limits.
As a guide, and provided the commercial butane or commercial propane being tested conforms to the requirements listed in Table 1, an operator normally remains within recommended occupational exposure limits provided inhalation of the commercial butane or commercial propane/air mixture does not exceed three 10 s periods during each test and not more than two tests per hour are performed in the course of an 8 h working day. This guidance only takes account of the operator's exposure whilst conducting odour tests. Other potential exposures should be assessed in order to estimate total exposure.

5.4 Filling ratios and developed pressures

The maximum filling ratios and developed pressures for the containers in which the commercial butane or propane is supplied shall conform to BS EN 1439 or BS EN 13096.

6 Precision and interpretation of test results

Most of the methods of test given in Table 1 contain a statement of the precision, i.e. repeatability and reproducibility, to be expected from them but, in cases of dispute, the procedure described in BS EN ISO 4259, which uses precision data in the interpretation of test results, shall be used.

Table 1 **Limiting requirements for properties of commercial butane and commercial propane**

Property	Commercial butane limit	Commercial propane limit	Test method
Gauge vapour pressure, at 40 °C (measured or calculated) (kPa), max. (see **D.1**)	505	1 550	BS EN ISO 4256 or Annex A (see **5.1**)
Total sulfur content (mg/kg), max	200	200	ASTM D3246 [A)] or ASTM D6667
Mercaptan sulfur content (mg/kg), max. [B)]	50	50	BS 2000-272
Hydrogen sulfide content (mg/m^3), max. (see **D.2**)	0.75	0.75	Annex C or absorption tube [C)]
Ammonia content (mg/m^3 in the vapour phase), max.	2.3	2.3	Absorption tube [D)]
Odour [E)]	Distinctive and unpleasant at 20% of the lower flammable limit	Distinctive and unpleasant at 20% of the lower flammable limit	Annex B (see **5.3**)
Copper corrosion, 1 h at 40 °C, max.	Class 1	Class 1	BS EN ISO 6251
Water content	Pass	Pass	BS EN 15469
Tendency to freeze in valves	–	Pass	BS EN ISO 13758
Dienes content [F)], mole percent, max.	0.5	0.5	BS EN 27941 or ASTM D2163 [G)]
Ethylene content, mole percent, max.	–	1.0	BS EN 27941 or ASTM D2163 [G)]
Alkynes content, mole percent, max.	0.5	0.5	ASTM D2163 [G)]
C4 and higher hydrocarbons content, mole percent, max.	–	10.0	BS EN 27941 or ASTM D2163 [G)]
C5 and higher hydrocarbons content, mole percent, max.	2.0	2.0	ASTM D2163 [G)]
R number, max. [H)]	10	10	BS 2000-317
O number, max.	33	33	BS 2000-317

A) ASTM D3246 should only be used when the total sulfur content is less than 100 mg/kg.

B) The result, expressed in accordance with BS 2000-272 as x mg/m^3, may be converted to y mg/kg by applying $y = 0.39x$ for commercial butane and $y = 0.51x$ for commercial propane.

C) Absorption tubes for hydrogen sulfide should be capable of detecting hydrogen sulfide at the limit specified in this table.

D) Absorption tubes for ammonia should be capable of detecting ammonia down to approximately 0.4 mg/m^3 (0.5 ppm). This test is sensitive to volatile amine compounds. These materials, like ammonia, are corrosive towards metals that might be used in LPG equipment. Therefore, a reading above the limit specified for ammonia should be regarded as failure to conform with this standard, even though the level of ammonia present might be below the specified limit.

E) The requirement for odour only applies to LPG that has been stenched.

F) EC Directive 67/548/EEC [3] (substances) and Directive 1999/45/EC [4] (preparations) classify commercial propane and commercial butane according to their hazardous properties. LPG containing more than 0.1% (m/m) of any substance classified as carcinogenic is also required to be classified as carcinogenic. Users of this British Standard should be aware of this requirement when making contractual arrangements, since commercial propane and commercial butane might contain the substance 1,3 butadiene which is classified as a Class II carcinogen.

G) For components of commercial butane or commercial propane not described in BS EN 27941 or ASTM D2163, gas chromatographic equipment such as that described in BS 5443 may be employed for the compositional measurement. Suitable columns should be used and various types are available commercially. The equipment should be calibrated with appropriate reference gas mixtures from a specialist supplier and the analyst should ensure that the equipment is capable of resolving satisfactorily components at the concentration limits required by this British Standard.

H) This test should be carried out prior to the addition of methanol since liquefied petroleum gases which contain alcohols might give erroneous results when tested by this method.

NOTE Annex D provides some explanatory notes on properties and test methods.

Annex A (normative) Method of calculation of gauge vapour pressure from compositional analysis of commercial butane or commercial propane

A.1 Principle

The composition of a sample of commercial butane or commercial propane is determined using gas chromatography. The gauge vapour pressure of the sample is calculated from the partial gauge vapour pressures of the components and their concentrations obtained from the analysis.

A.2 Determination

Use the method described in BS EN 27941 or ASTM D2163 to determine the proportion of each constituent present in excess of 0.1 mole percent in the gas sample.

A.3 Calculation

A.3.1 Calculate the partial gauge vapour pressure (in kPa) due to each component in the gas as follows:

$$\text{partial gauge vapour pressure} = VP \times C$$

where

VP is the gauge vapour pressure factor of the specific component at 40 °C indicated in Table A.1 (in kPa);

C is the mole fraction of the component in the gas.

A.3.2 Add the partial gauge vapour pressures due to all of the components determined and round the sum up to the nearest 1 kPa.

A.4 Reporting

Report the sum of the partial gauge vapour pressures calculated as in **A.3.2** as the gauge vapour pressure of the commercial butane or commercial propane sample.

A.5 Precision

Precision limits are not applicable to a calculation procedure.

Table A.1 **Factors for determining the gauge vapour pressure of commercial butane and commercial propane**

Component	Gauge vapour pressure factor VP at 40 °C kPa
Methane	38 230
Ethane	5 613
Ethylene	8 805
Propane	1 353
Propene	1 661
2-methylpropane	531
n-butane	376.9
But-1-ene	457
2-methylpropene	466
Cis-but-2-ene	336.5
Trans-but-2-ene	364.8
Buta-1,2-diene	272.2
Buta-1,3-diene	436
2-methylbutane	151.3
Pentane	115.5
Pent-1-ene	141.5

NOTE 1 The above factors for gauge vapour pressure are empirical values to be used only in procedures described in this method.

NOTE 2 Source of data: the vapour pressure blending factors of components present in liquefied petroleum gas, as indicated in the table, are primarily calculated using so-called Antoine coefficients as published in Reid, Pausnitz and Sherwood, 1977 [5].

Annex B (normative) Method of test for odour of commercial butane or commercial propane

B.1 General

This annex describes a method for assessing the odour of commercial butane or commercial propane which has an odour due either to the presence of odorous components or which is imparted by the addition of odorants.

*NOTE See the warning given in **5.3**.*

B.2 Principle

The gas is vaporized and diluted with purified air so that the mixture contains the gas at a concentration of 20% of the lower flammable limit [2)] in air. The odour of the gaseous mixture is assessed by at least three observers.

B.3 Material

B.3.1 *Activated charcoal*, particle size 1.18 mm to 1.70 mm, for purifying the air stream.

[2)] The lower flammable limit in air may be taken to be: butane 1.4% (v/v), propane 1.7% (v/v).

B.4 Apparatus

B.4.1 *Air purifier column*, consisting of a drying tower of approximately 200 mL capacity.

B.4.2 *Flowmeter*, such as one operating on the floating element principle, for air; range 5 L/min to 15 L/min.

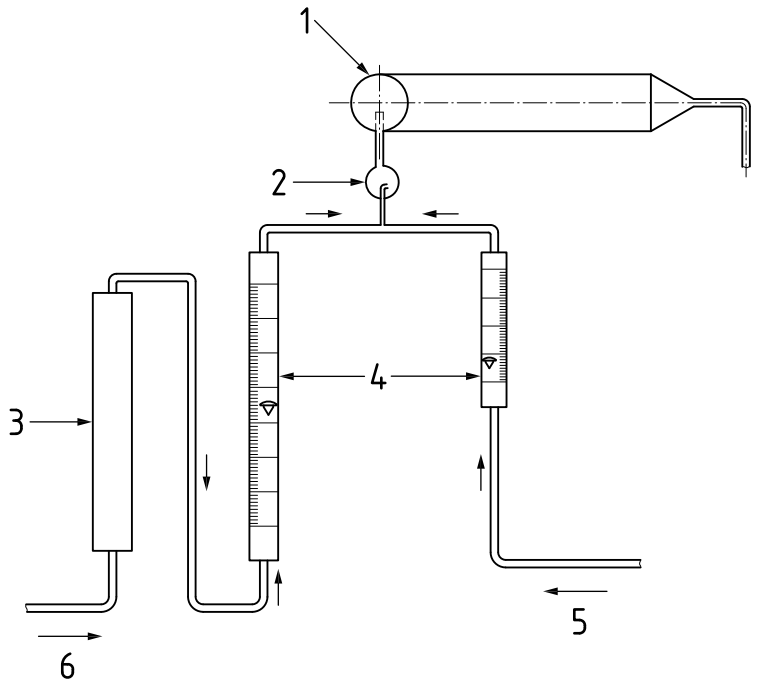
B.4.3 *Flowmeter*, such as one operating on the floating element principle, for gas; range 5 mL/min to 150 mL/min.

B.4.4 *Gas mixing bulb*, approximately 30 mm in diameter with a jet 4 mm in diameter.

B.4.5 *Glass funnel*, diameter approximately 75 mm.

*NOTE The apparatus is shown in Figure B.1 and consists of the parts detailed in **B.4.1** to **B.4.5**.*

Figure B.1 **Apparatus for assessing odour of commercial butane or commercial propane**



Key

1	Glass funnel	4	Flowmeter
2	Mixing bulb	5	Stenched gas
3	Air purifier column	6	Air

B.5 Procedure

Pass air through the air purifier column (**B.4.1**) at the specified rate as measured by the air flowmeter (**B.4.2**). The air flow rate for propane shall be 11.7 L/min and that for butane shall be 14.2 L/min. Place the nose inside the rim of the funnel (**B.4.5**) and inhale gently; check that the air is odourless.

Pass the stenched gas through the gas flowmeter (**B.4.3**) at a rate of 40 mL/min. Assess the odour of the gas-air mixture using at least three observers.

B.6 Expression of results

If the odour is judged to be distinctive and unpleasant by all observers, the batch which the sample represents shall be reported as conforming to this British Standard.

Annex C (normative) Method for determination of hydrogen sulfide in commercial butane or commercial propane

C.1 Principle

A measured volume of vaporized gas is passed through a prepared paper and the stain obtained is compared with standard stains. The concentrations determined are in the range 0.75 mg/m^3 to 6 mg/m^3.

C.2 Apparatus

NOTE The stainless steel used for the apparatus is austenitic stainless steel.

C.2.1 *Stainless steel sample container*, not less than 200 mL capacity.

NOTE 1 The sample container should be used with the ullage tube at the top.

NOTE 2 It is recommended that, where possible, this test be carried out on commercial butane or commercial propane drawn, as liquid, direct from the container rather than collected in a sample container; this avoids errors that might arise from the tendency of stainless steel to absorb hydrogen sulfide.

C.2.2 *Stainless steel quick release pressure coupling.*

C.2.3 *Water bath*, capable of being maintained at 40 °C ±2 °C.

C.2.4 *Tubes and valves*, sampling lines, a coil of approximately 2 m × 3 mm outside diameter tube, a 3-way stopcock and a needle valve for flow control, all in stainless steel.

C.2.5 *Test paper holder*, as shown in Figure C.1.

C.2.6 *Water manometer.*

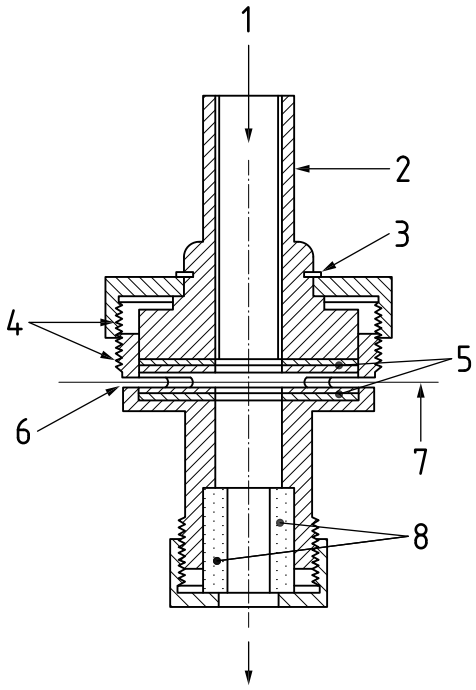
C.2.7 *Wet gas meter*, preferably passing 0.25 L of gas per revolution.

C.2.8 *Reference stains.* [3)]

NOTE Reference stains should be protected from exposure to light when not being used.

[3)] A suitable set of reference stains is available from the Energy Institute (see <www.energyinst.org> [last viewed 24 November 2014]). These reference stains comprise four standards corresponding to 0.75 mg/m^3, 1.5 mg/m^3, 3.0 mg/m^3 and 6.0 mg/m^3.

Figure C.1 **Test paper holder**



Key

1	Sample in	5	PVC washers attached with adhesive
2	Epoxide resin protective film	6	Paper feed slots
3	Spring clip	7	Test paper
4	Screwed fit	8	Rubber bush

C.3 Reagents

Lead acetate test papers are required, and are prepared from reagents of recognized analytical grade and water conforming to BS EN ISO 3696:1995, grade 3 as follows.

Dissolve 10 g of lead acetate trihydrate, $Pb(CH_3COO)_2.3H_2O$, in 90 mL of water. Add 5 mL of acetic acid (glacial, 17 mol/L) and 10 mL of glycerol to the solution and mix well. Prepare this solution freshly for each batch of test papers.

Immerse strips of chromatographic paper 20 mm wide and about 100 mm long, vertically in the solution, contained in a 100 mL measuring cylinder, for 1 min. Withdraw the strips from the liquid, allow the excess liquid to drain off, suspend them vertically and allow to dry as completely as possible at room temperature in an atmosphere free from H_2S. When dry, cut off and discard the top and bottom 25 mm of the treated strips to leave the test papers.

NOTE There should be no stain visible on a test paper before use. Lead acetate papers purchased in bulk might be satisfactory if cut to size (20 mm × 50 mm) and damped with a fine spray of water.

Store the test papers in a stoppered, wide necked, dark bottle to protect them from air and light. Use the test papers within 14 days of preparation.

C.4 Procedure

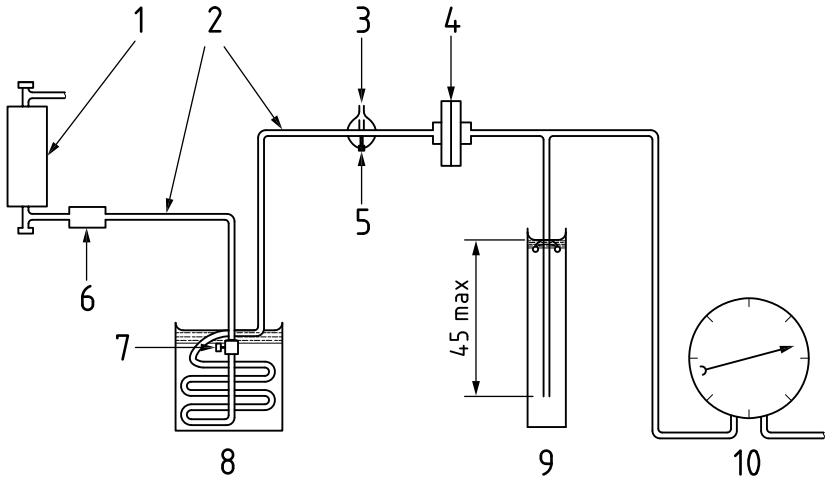
Assemble the apparatus as shown in Figure C.2 (but see **C.2.1**, Note 2) with the coil and needle valve (**C.2.4**) immersed in the water bath (**C.2.3**), maintained at 40 °C ±2 °C. Fit the test paper centrally between the gaskets of the test paper holder (**C.2.5**) and screw the holder finger tight. Close the needle valve tightly and open the lower valve on the sample container (**C.2.1**). Take the reading on the wet gas meter (**C.2.7**), open the needle valve and adjust it to give a flow rate of vaporized gas of 125 mL/min.

When the wet gas meter indicates that 1 250 mL of gas has passed through the system, turn the 3-way stopcock to the vent position and close the lower valve on the sample container. Remove the test paper from the holder and immediately compare the stain on it with the reference stains (**C.2.8**).

If the test paper is stained on both sides, indicating that the hydrogen sulfide has not been fully absorbed by the paper, prepare fresh test papers and repeat the test. If both sides of the fresh test paper are stained, repeat the test using a reduced volume of gas to give an indication of the concentration of hydrogen sulfide present.

Figure C.2 **Apparatus for determination of hydrogen sulfide in commercial butane or commercial propane**

Dimensions in millimetres



Key

1	Stainless steel sample container	6	Pressure coupling
2	Lines, coupling, 3-way stopcock and valve in stainless steel	7	Needle valve
3	Vent	8	Water bath [40 °C]
4	Test paper holder	9	Water manometer
5	3-way stopcock	10	Wet gas meter

Annex D (informative) Explanatory notes on properties and test methods

D.1 Gauge vapour pressure

The limits for gauge vapour pressure shown in Table 1 are given for a test temperature of 40 °C. For comparison with previous data obtained at other test temperatures, Table D.1 shows equivalent gauge vapour pressures.

Table D.1 **Gauge vapour pressures**

Temperature	Commercial butane kPa	Commercial propane kPa
37.8 °C	470	1 485
45 °C	586	1 760

D.2 Hydrogen sulfide

The limiting value of the hydrogen sulfide content specified is intended to ensure that the content of hydrogen sulfide in any part of the distribution system does not exceed 3 mg/kg. This is based on an assumption of distribution factors between the liquid and gaseous phases at normal ambient temperatures of 10.5 °C for butane and 5.5 °C for propane. At these levels, commercial butane or commercial propane is considered to be non-corrosive to metallic equipment in the vapour phase.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASTM D3700, *Standard practice for obtaining LPG samples using a floating piston cylinder*

BS 5443, *Recommendations for a standard layout for methods of chemical analysis by gas chromatography*

BS EN 437, *Tests gases – Test pressures – Appliance categories*

BS EN 589:2008+A1:2012, *Automotive fuels – LPG – Requirements and test methods*

BS EN ISO 10156, *Gases and gas mixtures – Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets*

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[1] HEALTH AND SAFETY EXECUTIVE. *Workplace exposure limits*. EH 40/2005. London: HSE Books, 2011.

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