BS EN ISO 11541:2002

Incorporating Amendment No. 1 to BS 3156-11.6:1997 (renumbers the BS as BS EN ISO 11541:2002)

Natural gas — Determination of water content at high pressure

The European Standard EN ISO 11541:2002 has the status of a British Standard

ICS 75.060

British Standards

National foreword

This British Standard is the official English language version of EN ISO 11541:2002. It is identical with ISO 11541:1997.

The UK participation in its preparation was entrusted to Technical Committee PTI/15, Natural gas and gas analysis, which has the responsibility to:

- — aid enquirers to understand the text;
- — present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- — monitor related international and European developments and promulgate them in the UK.

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

Cross-references

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This British Standard, having been prepared under the direction of the Sector Board for Materials and Chemicals, was published under the authority of the Standards Board and comes into effect on 15 July 1997

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, the EN foreword page, the ISO title page, pages ii to iv, pages 1 to 8, an inside back cover and a back cover.

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EUROPEAN STANDARD
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EN ISO 11541

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English version

Natural gas — Determination of water content at high pressure

(ISO 11541:1997)

Gaz naturel — Dosage de l'eau à haute pression
(ISO 11541:1997)

Erdgas — Bestimmung des Wassergehaltes
unter hohem Druck
(ISO 11541:1997)

This European Standard was approved by CEN on 9 October 2002.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Management Centre: rue de Stassart 36, B-1050 Brussels

Ref. No. EN ISO 11541:2002 E

Foreword

The text of ISO 11541:1997 has been prepared by Technical Committee ISO/TC 193, Natural gas, of the International Organization for Standardization (ISO) and has been taken over as EN ISO 11541:2002 by CMC.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2003, and conflicting national standards shall be withdrawn at the latest by May 2003.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of ISO 11541:1997 has been approved by CEN as EN ISO 11541:2002 without any modifications.

NOTE Normative references to International Standards are listed in Annex ZA (normative).

INTERNATIONAL
STANDARD

ISO
11541

First edition
1997-02-15

Natural gas — Determination of water content at high pressure

Gaz naturel — Dosage de l'eau à haute pression

Reference number
ISO 11541:1997(E)

Contents

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.

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.

International Standard ISO 11541 was prepared by Technical Committee ISO/TC 193, *Natural gas*, Subcommittee SC 1, *Analysis of natural gas*.

Descriptors: Natural gas, gas analysis, determination of content, water

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1 Scope

Water vapour may be present in natural gas due to, for example, natural occurrence in the well production stream, the storage of gas in underground reservoirs, transmission or distribution through mains containing moisture or other reasons.

This International Standard specifies a method of determining the water content of natural gas under pressures of more than 1 MPa, the upper pressure limit being determined by the maximum pressure that the apparatus can withstand. It is applicable to sweet natural gas and sour natural gas, containing hydrogen sulfide, with a water concentration of 10 mg/m^3 or more.[1]

NOTE Test data may be affected by alcohols, mercaptans, hydrogen sulfide and glycol contained in the sample gas, as these compounds react with the phosphorus pentoxide (P_2O_5) used to absorb the water vapour in the gas.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 10715*, Natural gas — Sampling guidelines*[2]

3 Principle

A measured volume of gas is passed through an absorption tube filled with phosphorus pentoxide. Water contained in the gas is absorbed by the phosphorus pentoxide and phosphoric acid is formed. The increase in the mass of the tube is deemed to be the mass of water present in the gas. The absorption of water vapour at pipeline pressure is favoured over absorption at ambient pressure for the following reasons:

a) the water vapour partial pressure is high;
b) the necessary amount of gas is transmitted in a shorter time.

4 Reagents and materials

4.1 Granulated phosphorus pentoxide, on a solid support with a moisture indicator (commercially available).

WARNING — Observe all safety precautions for phosphorus pentoxide. Any contact with skin or eyes and inhalation of vapours shall be avoided. Appropriate protective clothing shall be worn while working with phosphorous pentoxide.

4.2 Silica wool

WARNING — If not handled properly, silica wool can cause silicosis. A respirator is recommended for safe handling.

5 Apparatus

5.1 The test apparatus consists of the following components (see Figure 1, Figure 2 and Figure 3):

5.1.1 Pressure vessel body

5.1.2 End piece for pressure vessel

5.1.3 Filter tube, made of glass, with an outside diameter of 20 mm and a length of 32 mm, filled with silica wool.

5.1.4 Coupling between filter tube and absorption tube, made of stainless steel.

5.1.5 Absorption tube, made of glass, with an outside diameter of 20 mm and a length of 140 mm.

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[1] In this International Standard, all volumes are expressed at 288,15 K and 101,325 kPa.

[2] To be published.

5.1.6 End piece for absorption tube, made of stainless steel.

5.1.7 Plugs for absorption tube, made of stainless steel or acrylic plastic.

5.1.8 Needle valve, designed as a shut-off valve which will produce a slow pressure increase in the absorption tube, with a transfer line linking it to the sample probe and connector linking it to the pressure vessel inlet.

5.1.9 Pressure vessel, capable of accommodating the filter tube and the absorption tube.

WARNING — The pressure vessel shall be designed and have been tested for the pressure for which it will be used. Appropriate national safety regulations for pressure vessels and other equipment shall be observed.

5.1.10 Connector, for the pressure vessel outlet.

5.1.11 Manometer, for the appropriate pressure range.

5.1.12 Outlet needle valve, for venting, made of stainless steel.

5.1.13 Gas flow meter, for a maximum flow rate of 10 m^3/h.

5.1.14 Thermometer, incorporated in the flow meter outlet.

5.1.15 Barometer

5.1.16 Vent line

5.1.17 Heater

5.1.18 Sample probe valve

5.1.19 Manifold

5.2 The pressure vessel, the two needle valves, the manometer and all piping and fittings shall be designed for the maximum test pressure. If sour gas is measured, the material used shall be suitable for sour-gas service. The inside length of the pressure vessel shall be such that the filter tube, the coupling and the absorption tube will not be separated by a sudden pressure increase.

5.3 The connectors at the inlet and the outlet of the pressure vessel shall be easy to attach and to release.

6 Procedure

6.1 Preparation of the absorption tube

Fill the absorption tube (**5.1.5**) with granulated phosphorus pentoxide (**4.1**). The ends of the tube shall be flocked with silica wool (approx. 2 cm) such that no cavities remain. Close the absorption tube with marked plugs (**5.1.7**).

6.2 Preparation of the filter tube

Fill the filter tube (**5.1.3**) with silica wool.

6.3 Preparation of the test apparatus

6.3.1 *Initial weighing of the tubes*

Weigh the absorption tube with the marked plugs (= m_1) and also weigh the filter tube together with the coupling (**5.1.4**) immediately before assembly.

6.3.2 *Assembly of the pressure vessel*

Remove the marked plugs from the absorption tube and set them aside. Mount the end piece (**5.1.6**) on one end of the absorption tube. Join the other end of the absorption tube to the filter tube by means of the coupling.

Insert the tube assembly into the pressure vessel body (**5.1.1**) with the open end of the filter tube at the inlet side. Then close the pressure vessel.

Keep the marked plugs in a dessicator when not in use.

6.3.3 *Preparation of the sample probe*

The sample probe shall be clean and dry. The inlet needle valve with the connector for the pressure vessel inlet shall be mounted.

6.3.4 *Installation of the gas flow meter*

Join the connector for the pressure vessel outlet (**5.1.10**), the manometer (**5.1.11**) and the inlet needle valve (**5.1.8**) by high-pressure tubing. Join the flow meter (**5.1.13**) and the thermometer (**5.1.14**) to the outlet needle valve (**5.1.12**) and the vent line (**5.1.16**).

6.3.5 *Installation of the test apparatus*

Connect the pressure vessel (**5.1.9**) to the sample probe valve (**5.1.18**) and the flow meter using the connectors (**5.1.8**, **5.1.10**). Purge the sample probe upstream of the pressure vessel with sample gas.

6.4 Sampling

See ISO 10715 for general guidelines on sampling.

Make sure that the inlet and outlet valves (**5.1.8**, **5.1.12**) are closed and the sample probe valve (**5.1.18**) is opened. Open the inlet needle valve (**5.1.8**) carefully and pressurize the test apparatus. Inspect the test apparatus for leaks.

Open the outlet needle valve (**5.1.12**) carefully and adjust the flow to 2 m^3/h to 3 m^3/h. During sampling, record the atmospheric pressure and gas temperature and monitor the gas flow rate. After a sample of 1,5 m^3 to 3 m^3 has been passed through the apparatus, close the inlet needle valve (**5.1.8**) and depressurize the test apparatus. Record the quantity of gas which has passed through the apparatus (= V_0), as measured by the flow meter (**5.1.13**). Do not exceed one-half of absorption tube capacity or the test may be invalidated.

When sampling in a humid environment, special care shall be taken to avoid condensation on the tubes.

The maximum water concentration will depend on the actual pressure and temperature of the gas. The temperature of the sampling equipment and the test apparatus needs to be higher than the water dew point at the sampling pressure. If condensation should occur, thus invalidating the test data, heat the test apparatus to a temperature above the hydrocarbon dew point before making additional measurements.

6.5 Second weighing of the tubes

Remove the pressure vessel from the test apparatus and open it. Seal the absorption tube immediately after opening the pressure vessel, using the two marked plugs utilized for the initial weighing, and weigh again the absorption tube (= m_2). Weigh again the filter tube together with the coupling.

If the mass of the filter tube has increased by more than 5 mg/m^3, determine visually or by chemical analysis whether impurities have penetrated to the absorption tube. If penetration has occurred, the measurement is invalid.

Verify that the P_2O_5 packing in the absorption tube is still complete and that the P_2O_5 moisture indicator indicates that water has entered only the first half of the tube.

6.6 Parallel sampling

Simultaneous parallel sampling is recommended, especially if impurities are present. For parallel sampling, mount an asymmetric manifold (**5.1.19**) on the sample probe and attach two test apparatuses, as shown in Figure 3. Since condensate or other impurities are not distributed equally to the two apparatuses, agreement between the two results will confirm the correctness of the test. If the difference in the water concentration calculated for the two apparatuses is greater than twice the uncertainty of measurement (±5 % of the measured value), a repetition of the test is necessary.

7 Expression of results

7.1 Calculation

Calculate the water content, ρH_2O, expressed in milligrams per cubic metre, of the gas as follows:

$$\rho H_2O = \frac{m_2 - m_1}{V_1} \times 10^3$$

where

m_1 is the mass of the absorption tube, in grams, before sampling;

m_2 is the mass of the absorption tube, in grams, after sampling;

V_1 is the volume of the gas sample, in cubic metres (converted to normal conditions: 288,15 K, 101,325 kPa).

The conversion of the sample gas volume to normal conditions shall be made using the following equation:

$$V_1 = V_0 \frac{288{,}15 \times p_{\text{atm}}}{T \times 101{,}325}$$

where

V_0 is the gas sample volume, in cubic metres, as read from the flow meter;

T is the mean gas temperature, in kelvins, at the flow meter outlet;

P_{atm} is the atmospheric pressure during sampling, in kilopascals.

7.2 Uncertainty, detection limit

Under the conditions of a flow rate of 2 m^3/h to 3 m^3/h and a total transmitted gas volume of 1,5 m^3 to 3 m^3, the uncertainty is estimated to be ±5 % of the measured value (but not better than 5 mg/m^3) and the detection limit is estimated to be 10 mg/m^3.

The uncertainty and the detection limit may be improved by increasing the transmitted gas volume without increasing the rate.

This method is applicable even at a pressure below 1 MPa if the flow rate is reduced.

8 Test report

The test report shall include the following information:

a) a reference to this International Standard;

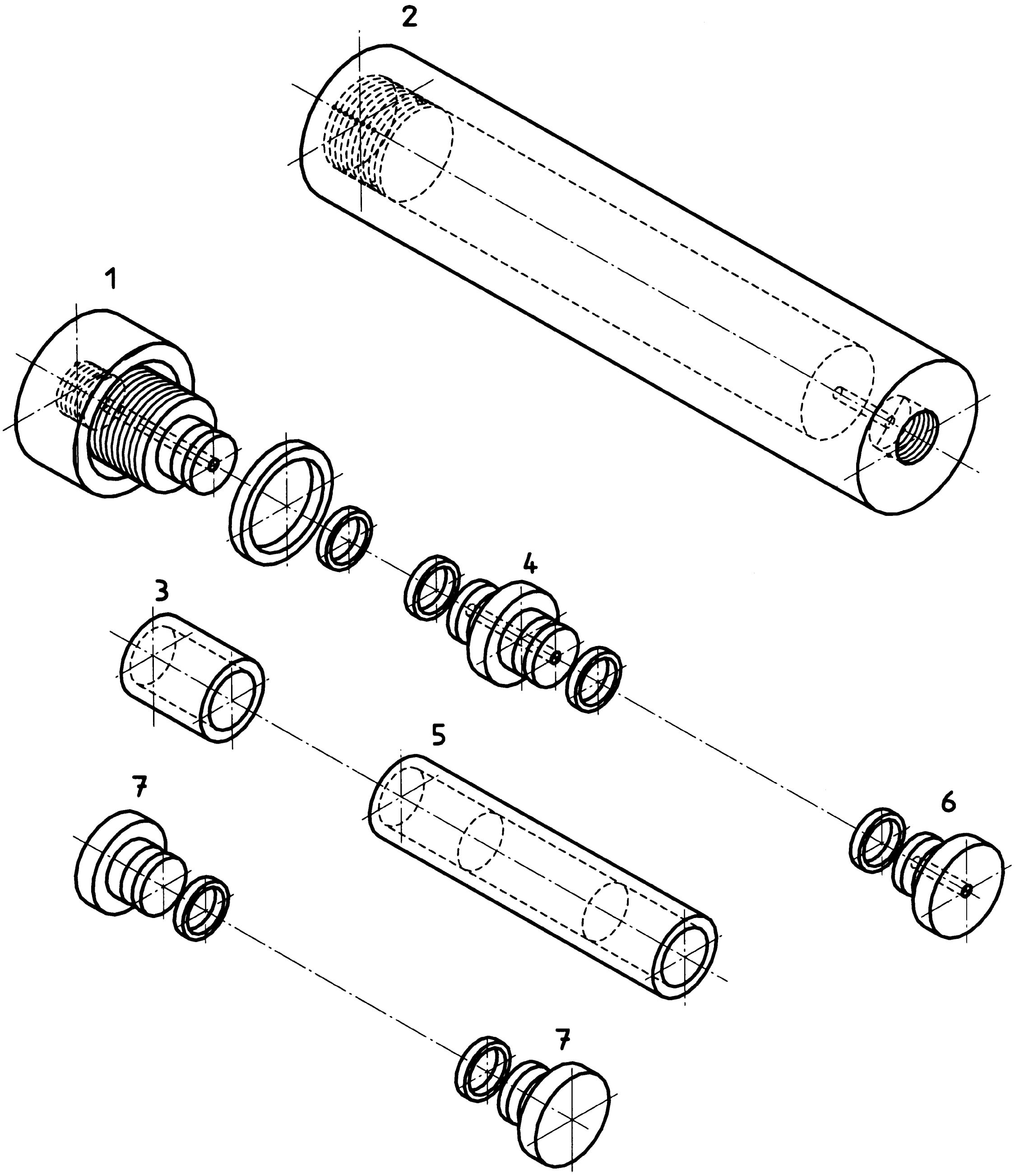
b) the place in the pipeline system at which the sample was taken;

c) the sampling method used;

d) the water content of the sample, reported to the nearest 1 mg/m^3 at 288,15 K and 101,325 kPa;

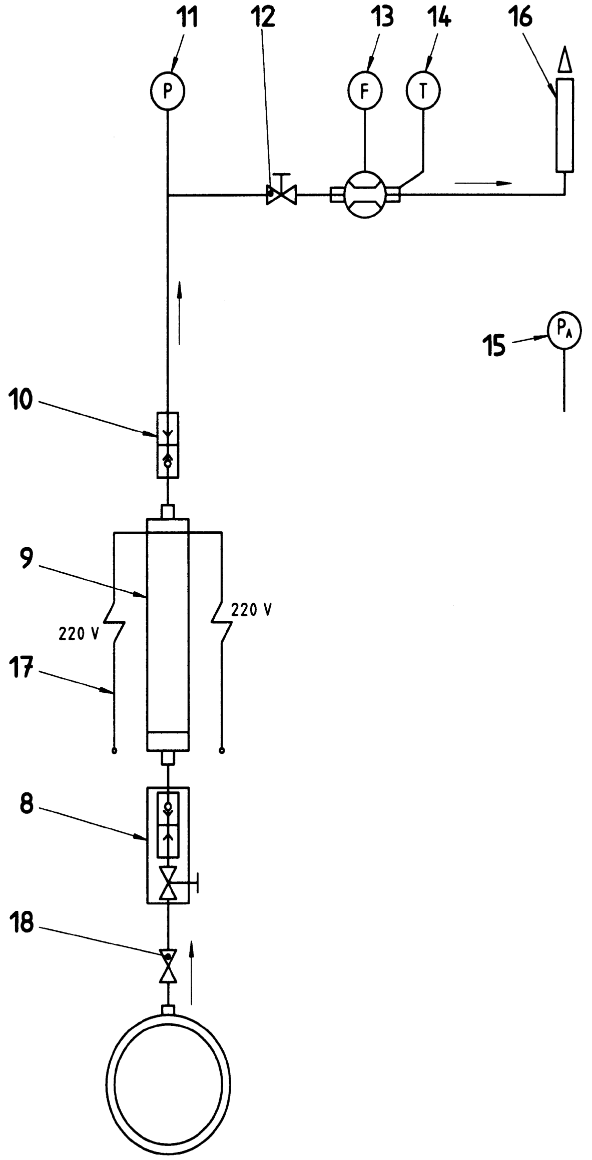
e) the actual gas pressure and the actual temperature at the sample probe for calculation of the actual water dew point;

f) any deviation from the procedure specified.



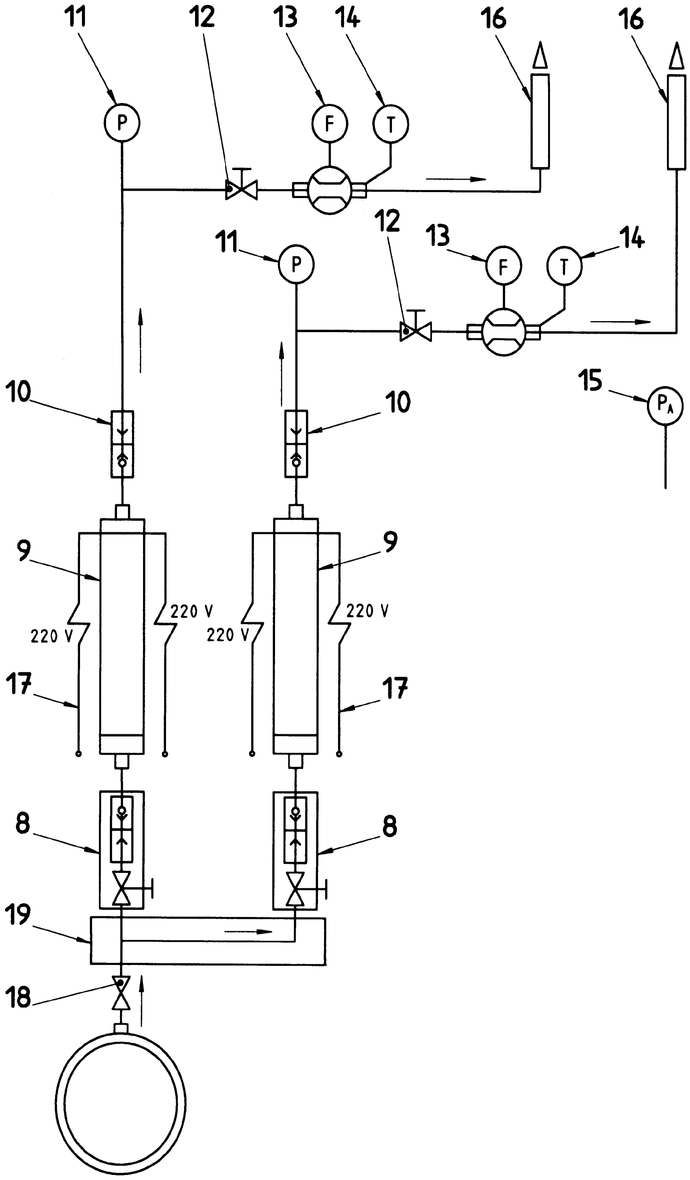
1	Pressure vessel body
2	End piece for pressure vessel
3	Filter tube
4	Coupling between filter tube and absorption tube
5	Absorption tube
6	End piece for absorption tube (stainless steel)
7	Plugs for absorption tube (stainless steel or acrylic plastic) (used during weighing)

Figure 1 — Pressure vessel with filter and absorption tube



8	Inlet needle valve, check valve and connector
9	Pressure vessel accommodating filter tube and absorption tube
10	Connector for pressure vessel outlet
11	Manometer
12	Outlet needle valve
13	Gas flow meter
14	Thermometer (incorporated in flow meter outlet)
15	Barometer
16	Vent line
17	Heater
18	Sample probe valve

Figure 2 — Schematic diagram of test apparatus



8	Inlet needle valve, check valve and connector
9	Pressure vessel accommodating filter tube and absorption tube
10	Connector for pressure vessel outlet
11	Manometer
12	Outlet needle valve
13	Gas flow meter
14	Thermometer (incorporated in flow meter outlet)
15	Barometer
16	Vent line
17	Heater
18	Sample probe valve
19	Manifold (asymmetric flow path)

Figure 3 — Schematic diagram of test apparatus with parallel sampling

Annex ZA (normative)
Normative references to international publications with their relevant European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE Where an International Publication has been modified by common modifications, indicated by (mod.), the relevant EN/HD applies.

Publication	**Year**	**Title**	**EN**	**Year**
ISO 10715	1997	*Natural gas — Sampling guidelines*	EN ISO 10715	2000

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