

Methods for

Sampling chemical products —

Part 2: Sampling of gases

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Co-operating organizations

The Technical Committee which has been working under the supervision of the Chemical Divisional Council, and which is responsible for the preparation of this British Standard, consists of representatives from the following Government departments and scientific and industrial organizations:

- British Colour Makers Association
- British Tar Industry Association
- Chemical Industries Association*
- Department of Industry, Laboratory of the Government Chemist*
- Fertiliser Manufacturers' Association
- Institute of Petroleum
- Institute of Trading Standards Administration*
- Institution of Gas Engineers
- Ministry of Defence
- Society for Analytical Chemistry*
- Standardization of Tar Products Tests Committee
- United Kingdom Atomic Energy Authority

The Government department and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the subcommittee entrusted with the preparation of this Part of this British Standard:

Individual experts

This British Standard, having been endorsed by the chairman of the Chemical Divisional Council was published under the authority of the Executive Board on 30 July 1976

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Contents

	Page
Co-operating organizations	Inside front cover
Foreword	iii
Section 1. General	
1 Scope	1
2 References	1
3 General considerations	1
Section 2. Sampling plan	
4 Introduction	1
5 Types of sample that may be required	1
6 Compressed or liquefied gases in cylinders	1
7 Gas in storage tanks	2
8 Gas flowing in pipes	2
9 Toxic or polluted atmospheres	2
Section 3. Sampling apparatus	
10 Introduction	2
11 Sampling probes	2
12 Sampling lines	3
13 Pressure regulators and flow controllers	7
14 Sample containers	7
15 Aspirators and exhaust pumps	11
Section 4. Sampling techniques	
16 Introduction	13
17 Sources of error	13
18 Leak testing	14
19 Metering	14
20 Methods for taking a spot sample	14
21 Methods for taking a continuous sample	14
22 Method for taking an intermittent sample	18
23 Method for taking a composite sample	18
24 Automatic method for taking intermittent and continuous samples	19
Section 5. Special applications of gas sampling	
25 Cryogenic liquids and liquefied gases stored under pressure	19
26 Permanent gases compressed in cylinders	19
27 Sampling for moisture determination at very low moisture content	20
28 Isokinetic sampling for determination of dust burden	20
29 Hazardous atmospheres	20
Appendix A Bibliography	22
Figure 1 — Typical water-cooled sampling probe	3
Figure 2 — Typical heated probe unit with water-cooled jacket	4
Figure 3 — Two designs of dust filter	5
Figure 4 — Cartridge filter	6
Figure 5 — Types of condensate trap	6
Figure 6 — Edwards bottle	7
Figure 7 — General design of glass gas sampling tubes	8
Figure 8 — Sampling vessels for use under reduced pressure	9
Figure 9 — Waterless gas holder	10

	Page
Figure 10 — Typical aspirator and exhaust pumps	12
Figure 11 — Apparatus for taking a continuous sample	15
Figure 12 — Apparatus for control of sampling rate in taking a continuous sample	16
Figure 13 — Apparatus for taking a continuous sample (modified Pexton–Hutchinson sampling apparatus)	17
Figure 14 — Apparatus for taking an intermittent sample (Dudden sampling device)	18
Figure 15 — Block diagram of assembly for isokinetic sampling	21
Table 1 — Solubility of gases in water	13
Publications referred to	Inside back cover

Foreword

This British Standard has been prepared under the authority of the Chemical Divisional Council following a conference convened by the British Standards Institution at which agreement was reached on the importance of standardizing techniques and apparatus for obtaining samples.

The other Parts of this British Standard are as follows.

- *Part 1: Introduction and general principles;*
- *Part 3: Sampling of liquids;*
- *Part 4: Sampling of solids;*
- *Part 5: Probability theory applied to sampling (under consideration).*

The Parts of this British Standard are intended to provide a basis for specifying methods of sampling in other British Standards, and also to act as a guide to manufacturers and users of materials not covered by British Standards.

Therefore this standard is not intended to be used as a working instruction for the person who actually takes the sample. It is essential that the users of Part 2 shall first read Part 1 in which the principles of sampling are discussed so that they will be competent to develop a detailed procedure for sampling any quantity of a gaseous chemical.

Terms used in the separate Parts are defined in section 1 of Part 1:1976. General safety precautions to be followed by the person taking the sample are dealt with in section 6 of Part 1:1976. The sampling of gases liquefied by pressure or low temperature is dealt with in section 6 of Part 3:1976.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 22, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

This Part of this British Standard specifies methods for the sampling of gaseous chemical products. It describes apparatus required, techniques to be applied and modifications necessary to these techniques for special applications.

2 References

The titles of the British Standards referred to in this standard are listed on the inside back cover.

3 General considerations

The sampling of gases probably presents fewer theoretical problems, but more practical difficulties, than those encountered when sampling solids or liquids. Because gases within a container tend to mix by diffusion and flowing gases can be mixed by inducing turbulence, lack of uniform composition is usually temporary and may not form the main source of sampling error. On the other hand the requirement to produce an uncontaminated sample of a product that is confined within closed vessels may restrict the choice of sampling technique.

When considering liquid or solid products (see Parts 3 and 4 of this standard) emphasis has been placed upon selecting an aliquot portion of the product, and possibly the physical reduction or after-treatment of that aliquot portion in order to produce a laboratory sample. When sampling gases the production of a discrete sample in an individual container is not always required because many industrial analyses are conducted on instruments designed to measure directly certain components or properties of the gas. These instruments frequently operate automatically, being installed in conjunction with facilities for continuous sampling. When laboratory analyses are to be made it is not uncommon to combine the sampling process with a preliminary stage of the analysis; for example, the pre-concentration of a trace constituent upon an adsorbent.

For reasons such as these this Part of the standard is devoted mainly to considering apparatus and techniques for obtaining samples of gases under various circumstances.

Section 2. Sampling plan

4 Introduction

When planning the sampling of solids or liquids it is customary to consider a convenient lot of material such as a consignment or a batch. This concept is less useful when planning gas sampling, for apart from the consignment of compressed or liquefied gases in cylinders most gases are delivered by pipeline and sampling is related to time and flow rate rather than to a finite volume of gas requiring to be sampled.

The sampling plan will be related, therefore, to

- a) the purpose of sampling, which will control the type of sample required;
- b) the circumstances of sampling, i.e. the nature of gas storage or flow.

5 Types of sample that may be required

Depending upon the information sought, the sampler may be asked to provide a spot, a composite, an intermittent or a continuous sample, as defined in 3.2 of Part 1:1976 of this standard. Under suitable conditions any one of these samples may also be regarded as a representative sample with respect to a stated volume or flow of gas.

The minimum volume of gas to be taken is related to the analyst's requirements, which may range from a fraction of a millilitre for a mass spectrometer analysis up to 20 litres for a sulphur determination by a combustion method. Furthermore, the analyst may specify a certain type of container suitable for tests planned and may need more than one sample to complete his programme. A suitable sample to analyse for main constituents may be useless for estimation of a trace impurity.

6 Compressed or liquefied gases in cylinders

The contents of each cylinder are essentially uniform in either the gaseous or liquid phase and the plan should be based upon the variance between containers, leading to selection of an appropriate number of containers to be sampled, each individual container forming a sampling unit. The principles involved are discussed in section 4 of Part 1:1976 of this standard.

7 Gas in storage tanks

It is unwise to assume uniform composition within a large gasholder if the contents are replenished from time to time, for stratification may persist for a considerable time after making an addition. However, it is rarely required to produce a sample representative of the entire content; further, it would be difficult to demonstrate that this aim had been achieved. In practice it is usual to take spot samples, or an intermittent or a continuous sample of gas leaving the holder for current use, analyses of these samples serving to detect stratification in the holder.

8 Gas flowing in pipes

The principles involved in sampling from streams are discussed in section 4 of Part 1:1976 of this standard. To recapitulate, variability may be encountered:

- a) due to stratification across the pipe section, or
- b) due to cyclic or periodic fluctuations in the manufacturing process, or
- c) due to a combination of these factors.

Stratification is investigated with the aid of an adjustable sampling probe which is used to collect samples in rapid succession whilst traversing the diameter of the pipe. From analyses of these samples the optimum position of the probe is selected to obtain samples which approximate to the average composition of the stream. Experience shows that in most cases this will be within the centre third of the cross section. If entrained dust or liquid droplets are required to be included quantitatively in the sample provision should be made for withdrawing the gas under isokinetic conditions as described in Part 1:1976 of this standard.

When the gas stream is subject to periodic fluctuations of composition the sampling plan will depend upon whether it is desired to measure the degree of fluctuation by means of spot samples, or to even out fluctuations by taking an average sample, or possibly to measure both the extreme and average compositions by passing a continuous sample into a recording instrument.

9 Toxic or polluted atmospheres

Sampling may be required for a number of reasons, including

- a) giving immediate warning of a hazardous gas concentration which requires continuous sampling into a detector under conditions of minimum time lag;

- b) determining how much the pollution varies over a period of time at one location which requires intermittent or continuous sampling;
- c) measuring the average level of pollution within a working area over a period of time which may be done by taking intermittent samples at a number of selected locations.

Section 3. Sampling apparatus

10 Introduction

Certain items of equipment which appear in one form or another in most gas sampling assemblies are described in this section. The basic parts of any system are the sampling probe, the sampling container line, the sample container, and the aspirator or exhauster. Auxiliary parts which may be needed include filters, traps, seals, pressure regulators or safety valves.

11 Sampling probes

The essential properties of the probe are as follows.

- a) The probe should have good mechanical properties which are not materially affected by the working temperatures; for sampling hot gas high resistance to thermal shock may be needed.
- b) The probe should be chemically inert towards the gas to be sampled and should not catalyse reaction between the constituents of the gas.
- c) The probe should not be porous or absorbent to any constituent of the gas.
- d) The material of construction should preferably be easy to machine and to join to the sampling lines in a manner free from leaks.

Some types of probe in common use are described in 11.1 to 11.3

11.1 Borosilicate glass probes. These are cheaply and easily made but cannot be used above 450 °C.

11.2 Metal probes. These are widely used. Mild steel is subject to attack by oxidizing gases above 300 °C and may be porous to hydrogen. For higher temperatures up to 1 100 °C a suitable alloy should be selected, bearing in mind that the stability of the alloy is influenced by the oxidizing or reducing properties, and also the sulphur content, of the hot atmosphere. Stainless steel and chromium irons may be used at temperatures up to 950 °C but the type of atmosphere determines the type of material to use and it is recommended that the manufacturers be consulted. Certain alloys containing nickel are suitable for use in sulphur free atmospheres at temperatures up to 1 150 °C. Water cooling is used to minimize the possibility of chemical reaction occurring during sampling. This precaution is particularly necessary if flue gases, for example, contain combustible constituents and the temperature is high enough for reaction to continue, or to be initiated by the hot probe.

Typical designs are illustrated by Figure 1 and Figure 2, the latter being recommended when moisture or oxides of sulphur are to be determined. The diameter of the gas sampling pipe should be kept to the minimum consistent with freedom from blockage.

11.3 Refractory probes. These are usually made of vitreous silica, porcelain, mullite or recrystallized alumina. They are brittle and may distort at high temperature if unsupported, and, with the exception of silica, may crack if subjected to sudden temperature changes. Silica probes can be used indefinitely at temperatures below 900 °C, and, despite a tendency to devitrify, still have a useful life up to 1 100 °C. They may be used intermittently for short periods up to a maximum temperature of 1 500 °C.

Because hot ash particles can flux with silica and cause deterioration of the probe, the probe may be protected by a sheath of alloy steel leaving only a few inches of silica exposed at the ends. It is recommended that the probe is bound with an insulating layer of asbestos yarn before inserting it into the sheath.

Glazed porcelain is normally satisfactory up to 1 400 °C but is subject to attack by hot ashes. If higher temperatures are encountered aluminous porcelain is suitable for continuous use up to 1 500 °C mullite up to 1 700 °C, and recrystallized alumina up to 1 900 °C.

12 Sampling lines

Sampling lines should be kept short, and should be made of material that is chemically inert and impermeable to the gas to be sampled. If long lines cannot be avoided it is often advantageous to make these of metal with screwed or brazed connections. The diameter of the tube should be selected with regard to the circumstances; a wide bore is advantageous for rapid purging of a large volume of gas but for high linear flow and rapid purging of lines a narrow bore is to be preferred. It is not generally necessary to exceed 6 mm internal diameter and a narrow bore is advantageous for rapid and complete purging. Tubing of rubber or plastics is useful for short connecting sleeves and may be used for longer sections provided it is known that the material is not permeable and that no detrimental contamination of the sample occurs.

