INTERNATIONAL STANDARD

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Gas analysis — Preparation of calibration gas mixtures using dynamic volumetric methods —

Part 2: Volumetric pumps

Analyse des gaz — Préparation des mélanges de gaz pour étalonnage à l'aide de méthodes volumétriques dynamiques —

Partie 2: Pompes volumétriques

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this part of ISO 6145 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6145-2 was prepared by Technical Committee ISO/TC 158, *Analysis of gases*.

ISO 6145 consists of the following parts, under the general title *Gas analysis — Preparation of calibration gas mixtures using dynamic volumetric methods*:

- *Part 1: Methods of calibration*
- *Part 2: Volumetric pumps*
- *Part 4: Continuous injection method*
- *Part 5: Capillary calibration devices*
- *Part 6: Critical orifices*
- *Part 7: Thermal mass-flow controllers*
- *Part 9: Saturation method*
- *Part 10: Permeation method*

Diffusion will be the subject of a future Part 8 to ISO 6145. Part 3 to ISO 6145, entitled *Periodic injections into a flowing gas*, has been withdrawn.

Annexes A and B of this part of ISO 6145 are for information only.

Introduction

This part of ISO 6145 is one of a series of standards dealing with various dynamic volumetric methods used for the preparation of calibration gas mixtures.

Gas analysis — Preparation of calibration gas mixtures using dynamic volumetric methods —

Part 2:
Volumetric pumps

1 Scope

This part of ISO 6145 specifies a method for the continuous production of calibration gas mixtures, containing two or more components, from pure gases or other gas mixtures by use of commercially available multi-piston, volumetric pumps. Pumps of this type may be employed to prepare gas mixtures in which the volume fractions of the gaseous components in the complementary gas range from 0,1 % upwards; the relative expanded uncertainty of measurement, U, obtained by multiplying the relative combined standard uncertainty by a coverage factor $k = 2$ is not greater than 0,5 %.

Lower concentrations may be obtained by cascading volumetric pumps, and the lowest volume fraction achievable by means of a two-pump cascade is 10^{-6}. Moreover, if pre-mixed gases are used instead of pure gases, much lower concentrations can be obtained.

The merits of this method are that a large quantity of the gas mixture can be prepared on a continuous basis, and that multicomponent mixtures can also be readily prepared.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 6145. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 6145 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 6143, *Gas analysis — Comparison methods for determining and checking the composition of calibration gas mixtures*

ISO 6145-1:1986, *Gas analysis — Preparation of calibration gas mixtures — Dynamic volumetric methods — Part 1: Methods of calibration*

3 Principle

A binary mixture of two gases, A and B, is prepared by passing each gas through one of a pair of single action piston pumps, each pump of which is driven by a synchronous motor. The volume fraction, φ_A, of component A, in the gas mixture is given by:

$$\varphi_A = q_A/(q_A + q_B) \quad (1)$$

in which q_A and q_B are the volumetric flow rates of the calibration component A and the complementary gas B respectively.

As is the case for all of the dynamic volumetric methods described in this series of standards, q_A and q_B shall be provided under identical conditions of temperature and pressure. If this is not so, and in particular if volumetric pumps are used at pressures above ambient atmospheric pressure the appropriate corrections are necessary. These are made by means of the ideal gas laws, or the virial equation in the case of gases showing significant departure from ideality.

4 Volumetric pump

4.1 Description

The volumetric pump consists of a pair of single-stage dosing pumps with single-action pistons driven by a single synchronous motor. The drive to one of the pumps is controlled through intermediate gears while that to the other is direct.

To prepare a two-component mixture of two gases A and B, the gases are to be supplied at ambient atmospheric pressure to the dosing pumps, and excess gas vented to the atmosphere through a system of bubblers. Two tubes are connected to the cylinder of each pump; the pure component, A or B, is aspirated through one tube and the other leads to a mixing chamber. The stroke rate of the one piston may be changed by gear selection while that of the other remains constant. By this means the volume fractions of A and B in the mixture are established. Figure 1 shows a schematic diagram of the principle.

Volumetric pumps of this type are commercially available and the following presents brief descriptions of three variants of the equipment:

a) The capacities of the cylinders are identical; the range of flow rate ratios is 1:1 to 9:1.

b) The capacity of the cylinder in which the piston drive is variable is 1/9 of that of the cylinder in which the drive is direct. In this arrangement the range of flow rate ratios is 9:1 to 99:1.

c) The capacity of the cylinder in which the piston drive is variable is 1/99 of that of the cylinder in which the drive is direct. In this arrangement the range of flow rate ratios is 99:1 to 999:1.

Some models are equipped with sets of gear wheels and others have integral switch gears and the ratios are selected by adjustment of dials.

Pumps can be arranged as a cascade to provide a means of preparation of gas mixtures of lower concentrations. As an example, two pumps of the third type, defined in c), can be operated in series to produce a binary mixture in which the volume fraction of the calibration component is 10^{-6}. It is also possible for two mixing systems to be combined in one pump and these systems can be switched to operate in either a parallel or a series configuration. In the series arrangement volume fractions as low as to 10^{-6} can be realized.

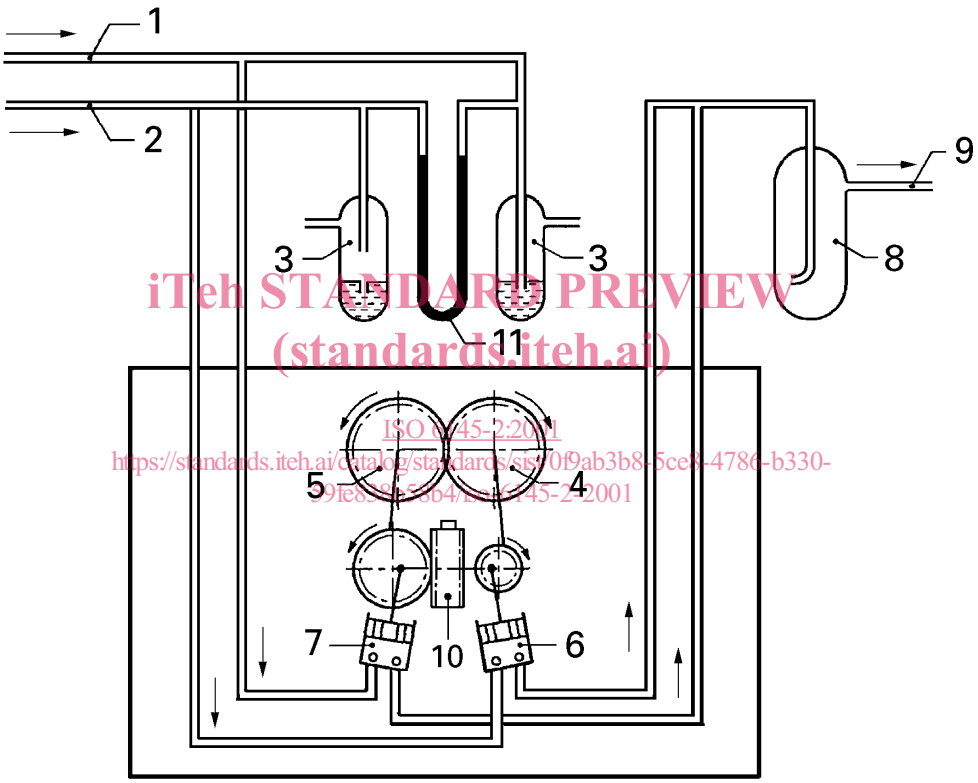
4.2 Precautions and validity limits

This method is applicable to the preparation of mixtures of non-reacting species, i.e. those which do not react with any material of construction of those parts of the pump, and the flow paths external to the pump, with which the gaseous components come in contact. Therefore pistons of the commercially available pumps shall be constructed in either bronze or another special alloy with ceramic coating. The latter material shall be claimed by the supplier to be chemically resistant to gases such as sulphur dioxide, hydrogen sulfide, ammonia, nitrogen dioxide, hydrogen chloride, and chlorine provided that the gases are dry. The gas-conveying tubes shall be made of corrosion-resistant stainless steel, known to be inert to the gases and gas mixture used (such types of stainless steel can be found in EN 10088-1[1]). Between the pistons and cylinders of some models of the pumps a perfluorinated-polyether fluid of low volatility (vapour pressure approximately 10^{-5} Pa at 25 °C) is used as a sealing and lubricating fluid. In other models, particularly older models, the pump system and gears are immersed in an oil bath and the low-vapour pressure oil which is used is of an appropriate grade (as marked on the pump).

Observe the general precautions common to all dynamic techniques of preparation. Particular care shall be exercised if the method is considered as a means of preparation of gaseous mixtures which contain components which form potentially explosive mixtures with air. Steps shall be taken to ensure that the apparatus is safe, for example by means of in-line flame arrestors in locations appropriate to the flow paths.

Although the pumps may be regarded as constant-flow devices, a calibration method is still necessary in order to confirm the ultimate gas concentration. As is the case for the other dynamic mixing methods presented in other parts of ISO 6145, it is essential to check the effectiveness of the mixing system to provide a homogeneous gas mixture; it is not satisfactory to rely upon the ratio of flow rates alone as the basis for expression of the gas composition unless the method has been validated for the gas mixture required.

This method of gas blending provides a constant flow of gas mixture of constant composition over a long period. The flow rate is limited to approximately 5 l/min for pumps currently available commercially. For some models however, the maximum flow rate is 0,75 l/min.



Key

1	Inlet for gas B
2	Inlet for gas A
3	Bubbler
4	Drive gear for cylinder A
5	Drive gear for cylinder B
6	Cylinder A
7	Cylinder B
8	Mixing chamber
9	Outlet for calibration gas mixture
10	Central drive unit
11	Manometer

Figure 1 — Schema of a volumetric pump for mixing gases