INTERNATIONAL STANDARD

ISO 6145-5

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

Part 5: Capillary calibration devices

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

Partie 5: Dispositifs d'étalonnage par capillaires

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Annex

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 6145-5 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 Part 3 to ISO 6145, entitled *Periodic injections into a flowing stream*, has been withdrawn.

Annex A of this part of ISO 6145 is for information only.

Introduction

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

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

Part 5:
Capillary calibration devices

1 Scope

This part of ISO 6145 specifies a technique for the continuous production of calibration gas mixtures from pure gases or gas mixtures using capillary devices in single or multiple combinations (gas dividers).

Single capillary systems can be used to provide gas mixtures where the minor component is in the range of volume fractions from 10^{-8} to 0,5.

The relative repeatability of this technique is approximately 2 %. This application is used in industrial gas mixing panels for the production of specific gas atmospheres.

Gas dividers can be used to divide gas mixtures prepared from gases or gas mixtures into controlled proportions by volume. These devices are capable of dilutions in the range of volume fractions from 0,1 to 0,9 of the primary gas with a relative repeatability of better than 0,5 %.

Traceability of the gas mixtures produced by a gas divider can be achieved by comparison of a mixture at the higher and lower end of the range with gas mixtures related to national or international gas standards. An example is given in annex A.

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*.

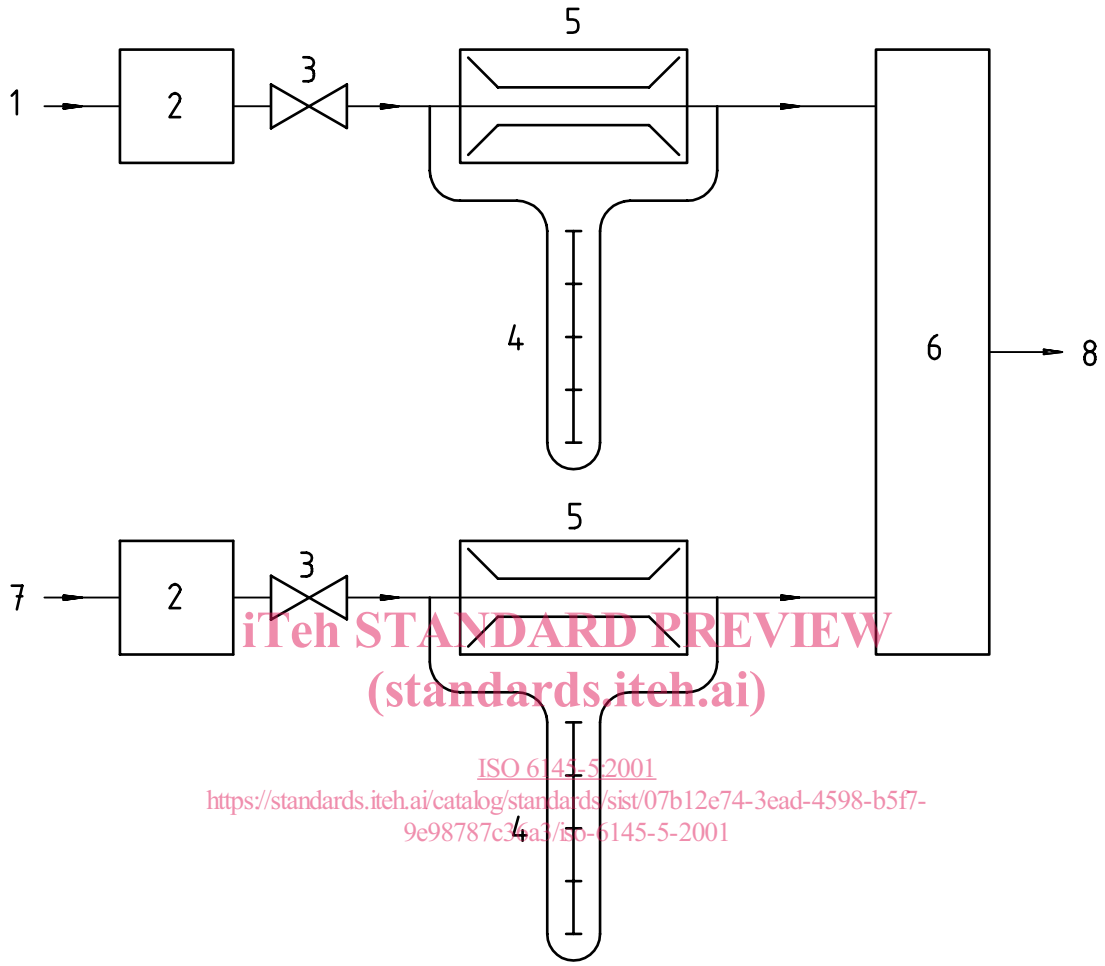
3 Singular or multiple capillary combinations

3.1 Principle

A constant flow of gas from a capillary tube under conditions of constant pressure drop is added to a controlled flow of complementary gas. The complementary gas may be derived from another capillary tube.

3.2 Apparatus

3.2.1 Two-capillary system, as shown in Figure 1 and consisting of the following.



Key

1	Gas A
2	Two-stage pressure regulator
3	Fine adjustment valve
4	Pressure differential manometer
5	Capillary
6	Mixing manifold
7	Complementary gas
8	Gas mixture

Figure 1 — Two-capillary blending system

3.2.1.1 Capillaries, each capillary is supplied with gas from a cylinder fitted with a two-stage pressure regulator, gas filter and a fine adjustment valve.

The appropriate capillaries shall be selected to give the required flows of gases A and B into the mixing manifold. These capillaries shall be calibrated using the method described in ISO 6145-1:1986, clause 3. The gas flow from one capillary is passed into a soap-film meter and readings are taken of the differential pressures required to provide a range of flows. A calibration curve is constructed by plotting pressure differences ($p_1 - p_2$) against flow rates. The gradient of this line will be the individual calibration factor K for the specified gas [see equation (2)]. The results of this calibration will allow a capillary to be selected such that the required flow can be obtained by adjusting the pressure drop across the capillary.

3.2.1.2 Two-stage pressure regulator, equipped with fine adjustment valves.

3.2.1.3 Differential manometer, capable of measuring the pressure drop across the capillary.

3.2.1.4 Gas manifold, fed by the flow from each capillary where mixing occurs to produce the calibration gas mixture at the outlet.

3.2.1.5 Gas filters, to filter the component gases, so as to prevent blockage of the capillaries.

3.2.1.6 Thermostatic controller (optional), to maintain the temperature of the capillaries constant. Variations in temperature can cause a significant change in the viscosity of the component gas passing through the capillary. For high accuracy, it is necessary to provide thermostatic control of the capillaries. With thermostatic control of a water-jacket to $\pm 1\ ^{\circ}C$, the volume fraction of the final mixture will not vary by more than $\pm 2\ \%$.

3.3 Procedure

Open the gas supply cylinders and adjust the two-stage pressure regulators to approximately 200 kPa gauge outlet pressure. Open the fine adjustment valves to give the pressure drop across the capillaries required for the desired flows.

3.4 Calculations

3.4.1 Capillary flow rate

The volume flow rate q_A of a gas A emerging from a capillary can be approximately expressed as:

$$q_A = \frac{\pi r^4 (p_1 - p_2)}{8\eta L} \quad (1)$$

where

r is the radius of the capillary tube;

p_1 is the inlet pressure to the capillary;

p_2 is the outlet pressure of the capillary;

η is the dynamic viscosity of the gas at the temperature of usage;

L is the length of the capillary tube.

For a given capillary this expression can be simplified:

$$q_A = K_A (p_1 - p_2) \quad (2)$$

where K_A is an individual factor for gas A.