International Standard ISO 5923

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Fire protection — Fire extinguishing media — Carbon dioxide

Protection contre l'incendie — Agents extincteurs — Dioxyde de carbone

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 5923 was developed by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, and was circulated to the member bodies in October 1982.

It has been approved by the member bodies of the following countries:

Australia
Canada
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Switzerland
United Kingdom
USA
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The member bodies of the following countries expressed disapproval of the document on technical grounds:

Belgium
Sweden

Fire protection — Fire extinguishing media — Carbon dioxide

0 Introduction

0.1 This International Standard is one of a series giving specifications for fire extinguishing media in common use and which are in need of specification for fire fighting purposes. These specifications are designed to establish that the medium in question has at least a minimum useful fire extinguishing capability and can therefore be reasonably sold for fire extinguishing purposes.

0.2 Requirements for media used in particular equipment will form the subject of future International Standards.

0.3 Annexes A, B, and C to this International Standard specify methods for determining, respectively, water, oil and total sulfur compounds contents and form an integral part of this International Standard.

Annexes D, E, F and G provide important information on, and give recommendations relating to, the safety and use of carbon dioxide, and they should be read carefully by all concerned with this medium. They do not, however, form part of the specification.

1 Scope and field of application

This International Standard specifies requirements for carbon dioxide for use as a fire extinguishing medium.

2 References

ISO 2591, *Test sieving.*

ISO 4705, *Refillable seamless steel gas cylinders.*

3 Definition

For the purpose of this International Standard, the following definition applies.

carbon dioxide: The chemical compound CO_2 used as a fire extinguishing medium.

4 Requirements

Carbon dioxide shall comply with the requirements of table 1, when tested by the appropriate method of test specified in clause 6.

Table 1 — Requirements[1)]

Property	Requirement
Purity, % (V/V) min.	99,5
Water content, % (m/m) max.	0,015
Oil content, ppm by mass, max.	5
Total sulfur compounds content, expressed as sulfur, ppm by mass, max.	1,0

1) Carbon dioxide obtained by converting dry ice to liquid will not usually comply with these requirements unless it has been properly processed to remove excess water and oil.

5 Sampling

5.1 General

Samples of carbon dioxide needed to perform all the tests required by this International Standard shall be taken from the same manufacturing lot, using identical sampling procedures.

NOTE — Attention is drawn to the need to design equipment for handling carbon dioxide such that it is either capable of withstanding the pressures involved or protected from them.

5.2 Sampling equipment

Rigid metal connections or flexible reinforced nylon hose should be used throughout the sampling equipment and shall be kept as short as possible. All components shall have a design pressure of not less than 137 bar.

5.3 Procedure

5.3.1 General

Two methods of sampling are specified:

a) direct sampling, in which the sample is passed to an evaporator and then directly to the analytical apparatus;

b) sampling in cylinders, in which case the sample is transferred in a cylinder to a laboratory.

Other methods may be used provided that they are shown to give equally representative samples on analysis (see annexes A, B and C).

5.3.2 Direct sampling

Connect the sampling valve by means of suitable connections (see 5.2) to an evaporating device and then via a T-piece (the free leg of which is connected to the dip-tube of a Drechsel bottle containing 50 mm of mercury covered by a layer of water on the carbon dioxide side) to the analytical apparatus. Thoroughly flush the connections, valves and the evaporating device with carbon dioxide before starting to take the sample.

5.3.3 Sampling in cylinders

Use a cylinder of water capacity 1,4 or 2,0 kg, complying with the requirements of ISO 4705, and with a valve at each end.

An internal copper dip-tube of diameter at least 5 mm and of length equal to one third of the length of the cylinder shall be brazed to the base of one valve, which shall be clearly identified. The cylinder shall be coated internally with tin [containing 1 % (m/m) of lead] applied by hot dipping the cylinder after the walls have been descaled.

First clean the sampling cylinder by removing both valves and washing the inside of the cylinder with carbon tetrachloride. Purge with a current of dry filtered air. Wash with methanol and repeat the purging. Degrease the valves using carbon tetrachloride, then refit them. The methanol and carbon tetrachloride used shall comply with the requirements specified in annex B, clause B.2.

Support the cylinder vertically with its dip-tube valve uppermost. Before taking the sample, thoroughly flush the cylinder with a small quantity of liquid carbon dioxide, first through the top valve and then through the bottom valve. Repeat this flushing procedure, and leave the cylinder connected to the liquid carbon dioxide source via its lower valve. Then, with the upper valve closed, open the lower valve to admit liquid carbon dioxide to the cylinder. Partly open the upper (dip-tube) valve and continue filling until carbon dioxide snow is discharged from this valve. Close both valves. Open the top valve several times for brief intervals until only carbon dioxide gas is discharged from it. The free end of the dip-tube inside the cylinder will then be just above the liquid carbon dioxide level in the cylinder.

Samples shall be analysed as soon as reasonably practicable after collection. To withdraw the sample for analysis, support the sampling cylinder vertically with the dip-tube valve at the top. Connect the bottom valve of the sampling cylinder (liquid carbon dioxide) to an evaporating device and thence via a T-piece, the free leg of which is connected to a lute as described in 5.3.2, to the analytical apparatus. Thoroughly flush the connections, valves and the evaporating device with carbon dioxide before starting the analysis.

When sampling for the determination of water content, heat the connections to above the dew-point to prevent condensation during purging.

6 Methods of test

6.1 Safety warning

Attention is drawn to the need to design equipment for handling carbon dioxide such that it is either capable of withstanding the pressures involved or protected from them.

6.2 Purity

Determine the purity by gas-liquid chromatography, using generally accepted laboratory techniques, or use a volumetric analyser.

The method used shall be capable of determining the purity with an accuracy of at least 0,1 %.

The sample shall not constitute more than 10 % of the original quantity of carbon dioxide contained in the sample container.

6.3 Water content

Determine the water content by the method specified in annex A or by any other method giving equivalent results.

6.4 Oil content

Determine the oil content by the method specified in annex B or by any other method giving equivalent results.

6.5 Total sulfur compounds content

Determine the total sulfur compounds content by the method specified in annex C or by any other method giving equivalent results.

7 Packaging and labelling

7.1 Carbon dioxide shall be shipped and stored in containers that will not alter the medium or be detrimentally affected by it.

NOTE — The containers may need to comply with national regulations.

7.2 Containers shall be marked with the following information:

a) supplier's name and address;

b) "Carbon dioxide";

c) package identification number;

d) the number of this International Standard, i.e. ISO 5923;

e) recommended storage precautions.

Annex A

Determination of water content

A.1 Principle

Gravimetric determination of the water content by passing a sample of the gas over phosphorus pentoxide.

A.2 Apparatus and material

A.2.1 Two absorption tubes, U-shape, the length of the limbs being 100 mm and the diameter of the tubes being 12 mm, fitted with side arms and ground-glass drilled stoppers. The tubes shall be filled with the desiccant (A.2.5) which shall be held in position by small pads of cotton wool.

A.2.2 Flow meter (if desired), float type, suitable for measuring a carbon dioxide flow of 200 to 2 000 ml/min.

A.2.3 Gas meter, calibrated for 1 litre or 2,5 litres per revolution.

A.2.4 Test sieves, of aperture sizes 425 and 600 µm, complying with the requirements of ISO 3310/1.

A.2.5 Desiccant.

Sift powdered glass or clean, dry, washed sand and retain the portion that passes through a test sieve of aperture size 600 µm but is retained on a test sieve of aperture size 425 µm.

In general, follow the applicable recommendations and requirements of ISO 2591.

Quickly transfer to a stoppered container (a large weighing bottle or small stoppered jar is suitable) a volume of fresh phosphorus pentoxide and add about half as much by volume of the prepared powdered glass or sand. Vigorously shake the container to mix the components and fill the U-tubes (A.2.1) as quickly as possible with the mixture.

If it is prepared in this way, it should be easy to fill the tube with the desiccant. If it is not easy, it is probable that the phosphorus pentoxide was moist before addition of the powdered glass or sand.

Prepare the desiccant in small quantities, as required.

A.3 Sampling

Take the sample in a cylinder by the method described in 5.3.3. About 120 g of carbon dioxide is required for each determination.

A.4 Determination

After the evaporating device, connect the exit side of the T-piece to the absorption tubes (A.2.1), the flow meter (A.2.2), and the gas meter (A.2.3) in series, in that order.

Carefully open the regulating valve and absorption tube taps and allow the gas to flow at a flow rate of about 500 ml/min for 10 min; the carbon dioxide displaces the air in the absorption tubes. Close all taps, disconnect the absorption tubes and wipe the tubes surfaces with a dry, soft cloth. Place the absorption tubes in the balance case, leave for 20 min, then weigh them to the nearest 0,5 mg.

Reconnect the absorption tubes. Note the reading of the gas meter then allow the gas to pass at a steady rate of 500 to 1 000 ml/min for 1 h.

Close the taps and reducing valve. Note the gas meter reading.

Place the absorption tubes in the balance case, leave for 20 min, then weigh them to the nearest 0,5 mg.

A.5 Expression of results

The water content, expressed as a percentage by mass, is given by the formula

$$\frac{54{,}29\,(m_2 - m_1)}{V}$$

where

m_1 is the initial mass, in grams, of the absorption tubes;

m_2 is the final mass, in grams, of the absorption tubes;

V is the volume, in litres, at 20 °C and 760 mmHg[1)], of gas passed, read from the gas meter.

1) 1 mmHg = 133,322 Pa

Annex B

Determination of oil content

B.1 Principle

Vaporization of a liquid sample and removal of any oil by passing the gas through carbon tetrachloride. Removal of residual oil in the cylinder by washing with more carbon tetrachloride and combination of the two carbon tetrachloride solutions. Spectrometric measurement of the oil content at 3 460 nm (the C-H stretching frequency) by means of an infra-red spectrometer.

B.2 Reagents

All reagents shall be of recognized analytical grade.

B.2.1 Carbon tetrachloride, distilled.

The reagent shall not show an infra-red absorption peak at 3 460 nm.

B.2.2 Standard oil solution.

Dissolve 0,020 0 g of liquid paraffin in carbon tetrachloride, transfer quantitatively to a 100 ml one mark volumetric flask and dilute to the mark with carbon tetrachloride.

1 ml of this solution contains 200 µg of oil.

B.3 Apparatus

B.3.1 Two bubblers, as shown in figure 1.

B.3.2 Drechsel bottle, of capacity 250 ml.

B.3.3 Flow meter, float type, suitable for measuring a carbon dioxide flow of 200 to 2 000 ml/min.

B.3.4 Gas meter, calibrated for 1 litre or 2,5 litres per revolution.

B.3.5 Infra-red spectrometer and accessories, suitable for making measurements at 3 460 nm.

B.4 Sampling

Take the sample by the method described in 5.3.3. About 700 to 1 000 g is required for each determination.

NOTE — A set of cylinders should preferably be retained for sampling for the determination of oil content and should not be used for other purposes.

B.5 Procedure

B.5.1 Preparation of test solution

Place 100 ml of the carbon tetrachloride (B.2.1) in the Drechsel bottle (B.3.2) and 25 ml in each bubbler (B.3.1). Support the weighed sampling cylinder with the dip-tube valve at the top, connect the bottom valve of the weighed cylinder to the T-piece of the evaporating device and then to the Drechsel bottle, the two bubblers, the flow meter and the gas meter in series, in that order, using short rubber connections.

No carbon dioxide shall be allowed to pass to the atmosphere through the outlet of the T-piece.

Weigh the cylinder, totally expand the contents of the cylinder through the absorption train at a flow rate of about 1 000 ml/min, and read the volume of gas passed (this serves as a check on the amount of carbon dioxide used for the test).

NOTES

1 Some evaporation of the carbon tetrachloride will take place. If this is excessive, stop the flow of gas and refill the absorption bottles, noting the volume of carbon tetrachloride.

2 In view of the toxic nature of carbon tetrachloride, the effluent gas from this determination should be discharged to the outside air.

Reweigh the sampling cylinder, taking care to use the same valve fittings as at the first weighing. Remove the valve not attached to the dip-tube and wash the inside of the cylinder with 25 ml of the carbon tetrachloride. Wash the interior of the evaporating device and valves with carbon tetrachloride and combine this solution with the cylinder washings and the contents of the bubblers. Make up the combined solutions to some suitable, definite volume.

B.5.2 Preparation of blank test solution

Evaporate a volume of carbon tetrachloride, equal to the total volume (including any additions) of carbon tetrachloride used in the absorption train plus washings, to the volume of the combined solution (see B.5.1) and subsequently treat it in the same way as the test solution.

B.5.3 Spectrometric measurements

Following the manufacturer's instructions for the operation of the instrument, determine the absorbances of the test solution and of the blank test solution at the wavelength of maximum absorption (approximately 3 460 nm). From the calibration graph (B.5.4), deduce the masses of oil corresponding to the measured absorbances.

B.5.4 Preparation of the calibration graph

Prepare suitable dilutions of the standard oil solution (B.2.2) to cover the range within which the mass of oil in the sample is expected to be found. Measure the absorbance of each of these solutions as described in B.5.3. Prepare a calibration graph by plotting the masses of oil against the corresponding absorbances.

B.6 Expression of results

The oil content, expressed in parts per million by mass, is given by the formula

$$\frac{m_3 - m_4}{m_5}$$

where

m_3 is the mass, in micrograms, of oil in test solution;

m_4 is the mass, in micrograms, of oil in the blank test solution;

m_5 is the mass, in grams, of sample taken.

NOTE — The mass m_5 can be checked by calculation from the mass of 1 litre of carbon dioxide at 20 °C and 1 013 mbar (760 mmHg), which is 1,84 g.

Dimensions in millimetres

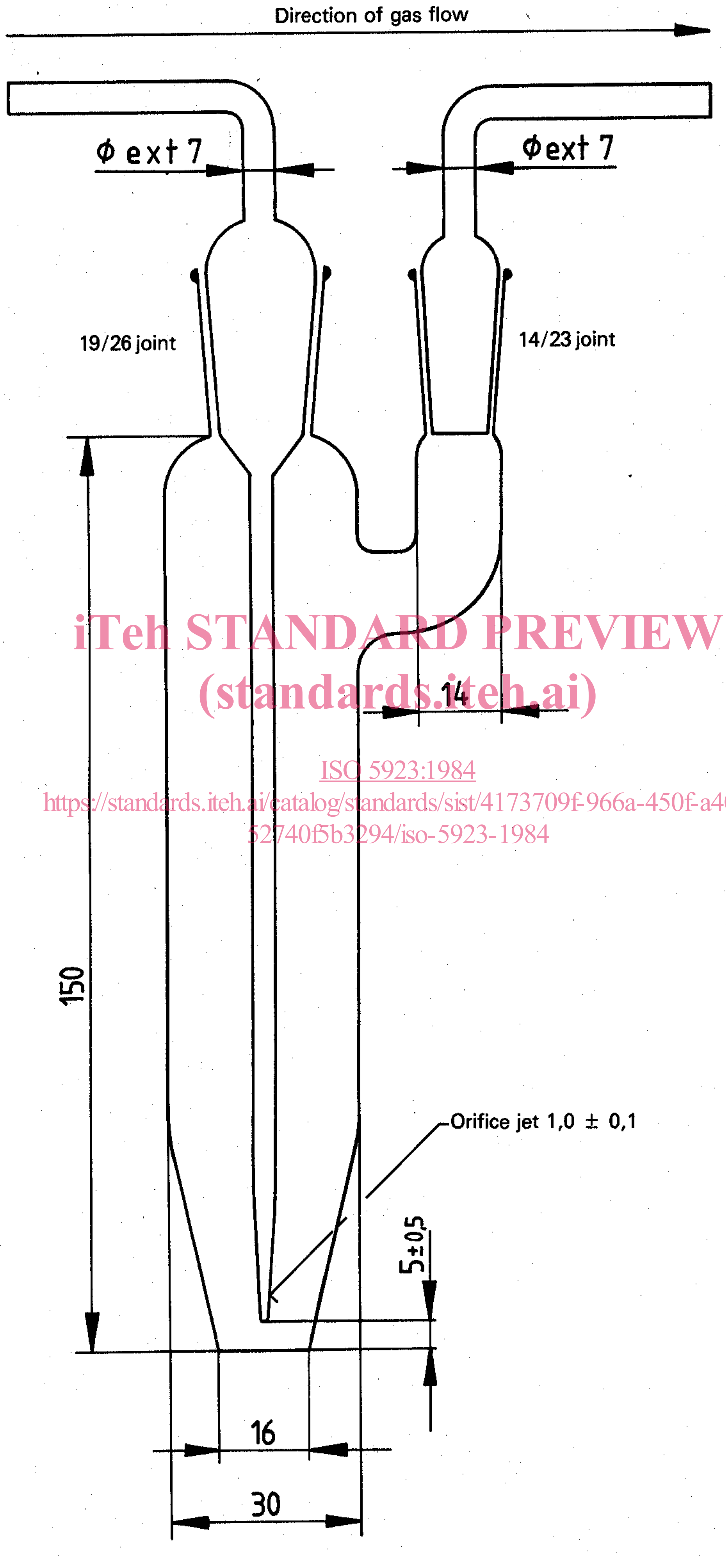

Figure 1 — Bubbler for the determination of oil content

Annex C

Determination of total sulfur compounds content

C.1 Principle

Reduction of any sulfur compounds present by passing equal volumes of the sample and purified hydrogen over silica wool at 900 °C. Removal of the hydrogen sulfide thus produced by passing the gases through neutral cadmium chloride solution. Determination of sulfur by adding a known amount of iodine solution and determining the excess iodine by titration with standard volumetric sodium thiosulfate solution.

C.2 Reagents

All reagents shall be of recognized analytical grade and the water used shall be distilled water or water of equivalent purity.

C.2.1 Hydrogen, gas produced electrolytically.

C.2.2 Hydrochloric acid, concentrated, ρ = 1,18 g/ml.

C.2.3 Soda lime, in lumps which pass a test sieve of aperture size 2 mm but which are retained on a test sieve of aperture size 1,8 mm.

NOTE — The soda lime should not have been used in other determinations where oxygen has been used, as explosions may occur.

C.2.4 Cadmium chloride, 50 g/l neutral solution.

Dissolve 5 g of cadmium chloride in 100 ml of water and add, drop by drop, approximately 1 mol/l sodium hydroxide solution until the first cloudiness appears.

C.2.5 Sodium thiosulfate, standard volumetric solution, $c(Na_2S_2O_3)$ = 0,02 mol/l solution.[1)]

C.2.6 Iodine, standard volumetric solution, $c(1/2\ I_2)$ = 0,02 mol/l solution.[1)]

C.2.7 Starch indicator solution.

Make a paste of 1 g of soluble starch with a little water, pour the paste, with constant stirring, into 100 ml of boiling water and boil for 1 min. Allow to cool.

C.3 Apparatus

NOTE — The apparatus is shown diagrammatically in figure 2.

C.3.1 Flow meter, float type, suitable for measuring a hydrogen flow of 200 to 2 000 ml/min.

C.3.2 Flow meter, float type, suitable for measuring a carbon dioxide flow of 200 to 2 000 ml/min.

C.3.3 Two furnace tubes, made of transparent silica, each 500 mm long, of internal diameter 16 mm, with one end reduced to 3 mm internal diameter.

Place a loose packing of silica wool not less than 200 mm long in the tube with a small plug of silica wool near the wide end to reduce radiation heating of the polyvinyl chloride connection.

C.3.4 Furnace and control: a twin-tube furnace, about 460 mm long, to operate at 900 °C, and fitted with a thermocouple and temperature indicator.

C.3.5 Soda lime tower, or suitable absorption tube.

C.3.6 'Y' tube.

C.3.7 Bubbler, as shown in figure 1.

C.3.8 Burette, of capacity 10 ml, complying with the requirements of ISO/R 385, class A.

C.3.9 Pipette, of capacity 2 ml, complying with the requirements of ISO 648, class A.

C.3.10 Test sieves, of aperture size 2 mm and 1,8 mm, complying with the requirements of ISO 3310/1.

C.4 Sampling

Take the sample in a cylinder by the method described in 5.3.3. About 120 g is required for each determination.

Connect the outlet of the evaporating device to the apparatus shown in figure 2. All connections shall be as short as possible and shall be made of polyethylene or polyvinyl chloride.

1) Hitherto expressed as "0,02 N standard volumetric solution".