

INTERNATIONAL STANDARD



3507

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Pyknometers

Pycnomètres

First edition — 1976-10-15

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UDC 666.1 : 542.2 : 531.756.4

Ref. No. ISO 3507-1976 (E)

Descriptors : pyknometers, specifications, dimensions.

Price based on 8 pages

FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

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 3507 was drawn up by Technical Committee ISO/TC 48, *Laboratory glassware and related apparatus*, and was circulated to the Member Bodies in October 1974.

It has been approved by the Member Bodies of the following countries :

Australia	Germany	South Africa, Rep. of
Austria	Hungary	Turkey
Belgium	Israel	United Kingdom
Bulgaria	Netherlands	Yugoslavia
Czechoslovakia	Poland	
France	Romania	

No Member Body expressed disapproval of the document.

Pyknometers

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies requirements for an internationally acceptable series of pyknometers for general laboratory use for the determination of the densities of liquids.

Specialized pyknometers for use with particular products, or otherwise not in common use, are excluded. Sufficient details to define such pyknometers should be included in International Standards specifying or describing their use.

A device suitable for adjusting the liquid level in the neck of the Reischauer pyknometer is shown in the annex.

2 BASIS OF ADJUSTMENT

2.1 Unit of volume

The unit of volume shall be the cubic centimetre (cm³), for which the name millilitre (ml) may be used.

2.2 Reference temperature

If the precise capacity is marked on a pyknometer, the verification temperature at which this precise capacity is determined shall also be marked. The temperature should preferably be 20 °C.

NOTE — When it is necessary in tropical countries to work at an ambient temperature considerably above 20 °C, and these countries do not wish to use the standard reference temperature of 20 °C, it is recommended that they adopt a temperature of 27 °C.

3 TYPES AND SERIES OF SIZES

Two types of pyknometer tube and three types of pyknometer flask are specified, as listed in table 1 and illustrated in figures 1 to 5. Types 1 and 2, of tubular form, are for suspension; types 3, 4 and 5, of flask form, are free-standing on flat bases.

Types 1 and 4, and type 2 if provided with caps, are recommended for use with volatile liquids. Type 5 is recommended for very viscous materials.

The series of sizes for each type of pyknometer shall be as shown in table 1.

NOTE — The nominal capacities in table 1 are expressed for convenience in millilitres (used here as a special name for the cubic centimetre) because density is commonly expressed in grams per millilitre, but the pyknometers are equally suitable for determination of density or relative density in any desired units.

TABLE 1 — Types and sizes of pyknometers

Type	Designation	Nominal capacities			
		ml			
1	Lipkin	1	2	5	10
2	Sprengel			5	10 25
3	Gay-Lussac			10	25 50
4	Reischauer				25 50
5	Hubbard				25

4 DEFINITION OF CAPACITY

4.1 precise capacity : The volume, in millilitres, of water at the reference temperature contained by the pyknometer, also at that temperature. The volume, according to type, is defined as follows :

Type 1 : Between zero lines of the two scales

Type 2 : From tip of jet to graduation line

Types 3 and 5 : To top of bore of stopper

Type 4 : To zero line of scale

The preferred reference temperature is 20 °C but other temperatures may be selected as appropriate.

4.2 nominal capacity : The precise capacity rounded to the nearest appropriate value given in table 1.

5 DIFFERENCE BETWEEN ACTUAL CAPACITY AND NOMINAL CAPACITY

The difference between the actual capacity and the nominal capacity of a pyknometer shall not exceed the appropriate maximum value shown in tables 2 and 3.

6 CONSTRUCTION

6.1 Material

Pyknometers should preferably be made from borosilicate glass of class 1 hydrolytic resistance¹⁾, and shall be as free as possible from visible defects and reasonably free from internal strain. Stoppers or taps shall be made from glass having similar thermal properties to that used for the pyknometers to which they are fitted. Pyknometers made from soda-lime glass may require more frequent calibration than those made from borosilicate glass.

6.2 Mass

The mass of a pyknometer shall not exceed the appropriate maximum value shown in tables 2 and 3.

6.3 Dimensions

Pyknometers shall comply with the appropriate toleranced dimensional requirements shown in tables 2 and 3. The additional dimensions which are specified by nominal values without tolerances are for the guidance of manufacturers.

6.4 Shape

The shapes of the five types of pyknometer shall be generally as shown in figures 1 to 5 and shall comply with the detailed requirements set out below.

All tapered portions of pyknometers shall be smoothly formed so as to avoid sharp shoulders which could entrap air bubbles.

6.4.1 Pyknometers of type 1 shall have an oval bulb, as illustrated in figure 1, which merges gradually into the tubes at each end.

The left arm of the pyknometer shall be bent as shown in figure 1, the distance from the end to the outside of the bend being 20 ± 2 mm and the included angle being 50 to 55° .

The two ends of the pyknometer shall be finished square with the axis of the tubes and smoothly fire-polished without constriction.

6.4.2 Pyknometers of type 2 shall have a cylindrical bulb with tapered ends which merge gradually into the adjoining tubes.

The two arms shall be bent at an angle of approximately 75° to the vertical and shall lie in the same plane as the U-portion of the pyknometer. One arm shall be drawn down to a smooth tapered jet, the end of which shall have a bore of approximately 0,5 mm and shall be ground smooth at right angles to the axis of the tube and slightly bevelled on the outside.

The end of the other arm of the pyknometer shall be finished square with the axis of the tube and smoothly fire-polished without constriction.

6.4.3 Pyknometers of type 2 may, if desired, be fitted with ground-on caps at the ends of the side arms. A pyknometer of this form shall comply with the following additional requirements :

The ground zones of the joints shall be such that the two caps are interchangeable, and the joints should preferably comply with the requirements for size 5/9 of ISO 383.

The cones of the joints shall be formed with a minimum distortion of the bore of the tube and such distortion shall be smoothly tapered. The tip of the jet shall project beyond the small end of the ground zone and shall meet the requirements of 6.4.2.

The caps shall be smoothly ground to a good fit on the cones and shall be of sufficient size to clear the tip of the jet.

6.4.4 Pyknometers of types 3, 4 and 5 shall stand vertically without rocking or spinning when placed on a level surface. They shall not topple when placed empty, with the stopper inserted, on a surface inclined at an angle of 15° to the horizontal.

6.4.5 Pyknometers of types 3 and 4 should preferably have a body shape similar to that shown in figures 3 and 4, in which the plane of maximum diameter is at approximately one-quarter of the distance from the base to the bottom of the neck.

6.4.6 Pyknometers of type 5 shall have a body shape as shown in figure 5, in which the upper end of the conical portion merges smoothly with the neck without a sharp shoulder. The radius of curvature between the lower end of the conical portion and the base shall not be less than 5 mm.

¹⁾ An International Standard (ISO 4789) covering the classification of laboratory glasses according to their hydrolytic resistance is in preparation.

6.5 Necks

The necks of pycnometer flasks shall comply with the following requirements :

6.5.1 For types 3 and 5, the top of the neck shall be finely ground at right angles to the axis of the flask so that there is no channel in which liquid can lodge between the stopper and the neck of the bottle. The outer edge of the top of the neck shall be slightly bevelled.

The ground zone of the neck shall extend below the bottom of the stopper when the latter is in position and there shall be no ridge at the lower end of the grinding.

6.5.2 For type 4, the portion of the neck bearing the graduated scale shall be cylindrical and the internal diameter shall be uniform over the entire scale length. The internal diameter of the neck above this portion shall not be constricted. The upper end of the neck shall be ground either as a socket with a strengthening bead above as shown in figure 4, or as a cone, as shown in figure 4a). In either case the grinding should preferably comply with the requirements of ISO 383, for the joint sizes listed in table 3.

6.6 Stoppers

Stoppers for pycnometer flasks shall be finely ground to fit the necks of the flasks and shall comply with the following requirements :

6.6.1 For type 3, the ground zone of the stopper shall extend above the neck of the flask when the stopper is in position in the flask and this portion shall also be finely ground.

The top of the stopper shall be ground at right angles to the axis and polished, and shall have a slightly bevelled edge.

The bottom of the stopper shall be finely ground at right angles to the axis and shall have a slightly bevelled edge.

The edges where the hole through the stopper intersects the top and bottom of the stopper shall be regular in outline and not chipped or countersunk.

The upper portion of the stopper shall have two inclined polished faces on opposite sides. These inclined faces shall not encroach on the ground zone of the stopper.

6.6.2 For type 4, the stopper or cap shall be smoothly ground to be a good fit in or on the neck of the flask, preferably to interchangeable requirements, as indicated in 6.5.2.

6.6.3 For type 5, the stopper shall comply with the requirements of the first, third and fourth paragraphs of 6.6.1. The underside of the stopper shall be smoothly ground to a concave shape forming part of a sphere, the resulting edges being cleanly formed without chipping.

7 GRADUATION LINES

7.1 General

7.1.1 Graduation lines shall be clean, permanent, uniform lines of thickness not exceeding 0,3 mm.

7.1.2 All graduation lines shall lie in planes at right angles to the axis of the tube on which they are situated.

7.2 Type 1

7.2.1 Position of scale

Each vertical arm of the pycnometer shall have a graduated scale of length 8 cm divided into millimetres. The two scales shall be on the same level when the pycnometer is in a vertical position. Dimensions limiting the position of the scale are given in table 2.

7.2.2 Length of graduation lines

The long lines representing each centimetre shall either extend completely round the circumference of the tube or leave a gap not exceeding 10 % of the circumference.

The length of the medium lines midway between the long lines shall be at least one-quarter of the circumference of the tube.

There shall be four short lines between consecutive long and medium lines, each of length at least one-eighth of the circumference of the tube.

The short and medium lines shall appear centrally down the front of the two tubes when the pycnometer is viewed in a vertical position with the bent arm to the left.

7.2.3 Figuring of graduation lines

The two scales shall be numbered with figures representing centimetres from 0 at the lowest long line to 8 at the top.

The figures shall be placed immediately above the long lines to which they refer and slightly to the side of the shorter lines, as indicated in figure 1.

7.3 Type 2

The pycnometer shall have a single graduation line completely encircling the arm which is not provided with a jet. This line shall be placed not less than 5 mm from the point where the tube begins to bend and not less than 20 mm from the open end of the tube.

7.4 Type 4

7.4.1 The neck of the pycnometer shall have a graduated scale of length 2 cm divided into millimetres. There shall be at least 5 mm of the tube of uniform bore above and below the graduated scale before the tube starts to expand.

7.4.2 The length and sequence of graduation lines shall comply with the requirements of the first three paragraphs of 7.2.2. The placing of the lines shall be as indicated in figure 4.

7.4.3 The long lines of the scale shall be numbered with figures representing millimetres, with 0 at the bottom, 10 in the centre and 20 at the top.

8 INSCRIPTIONS

The following inscriptions shall be permanently marked on all pyknometers :

- a) the symbol $\approx$ to indicate that the capacity is approximate and not accurately adjusted, followed by a number to indicate the nominal capacity;
- b) the symbol "cm³" or the symbol "ml" to indicate the unit of volume;
- c) as an alternative to inscriptions a) and b), or in addition to them, a figure showing determined capacity to the nearest 0,001 ml together with the temperature at which this determined capacity applies, for example "49,813 ml at 20 °C" (see 2.2);
- d) if required, a suitable abbreviation to indicate that the pyknometer is intended to contain (and not to

deliver) its nominal capacity. In order to obviate language difficulties, it is recommended that the letters "ln" be used for this purpose;

- e) the type of glass used or its coefficient of cubical expansion;
- f) the maker's or vendor's name or mark;
- g) for types 3 and 5, an identification number, which shall be repeated on the stopper. Identification numbers may also be marked on other types of pyknometer and their caps or stoppers.

9 VISIBILITY OF GRADUATION LINES, FIGURES AND INSCRIPTIONS

- 9.1 All figures and inscriptions shall be of such size and form as to be clearly legible under normal conditions of use.
- 9.2 All graduation lines, figures and inscriptions shall be clearly visible and permanent. Any filling which is used to improve visibility shall be sufficiently durable to obviate any significant loss in mass during use.

TABLE 2 – Dimensional requirements for pyknometer tubes (see 6.3)

Characteristic	Type 1 (Lipkin)				Type 2 (Sprengel)		
	(see figure 1)				(see figure 2)		
Nominal capacity, ml	1	2	5	10	5	10	25
Difference between actual capacity and nominal capacity, max., ml	± 0,2	± 0,3	± 0,5	± 1	± 0,5	± 1	± 2
Maximum mass (including cap for type 2, if fitted), g	30	30	30	30	25	30	40
Overall height, A, mm	175 ± 5				90	105	120
Height above scale, B, min., mm	40				—	—	—
Height from bulb to scale, C, min., mm	5				—	—	—
Distance between centres of vertical limbs, D, mm	28 ± 2				10	13	16
Length of side arms, E, mm	—				40	45	50
External diameter of tubing, F, mm	6				6	6	6
Internal diameter of tubing, G, mm	1 ± 0,1				1,5	1,5	1,5
Length from bottom of bulb to zero graduation line, H, mm	40				—	—	—
Length of bulb, H, mm	—				60	75	90
External diameter of bulb, J, mm	11	14	20	25	12	17	22

PYKNOMETER TUBES

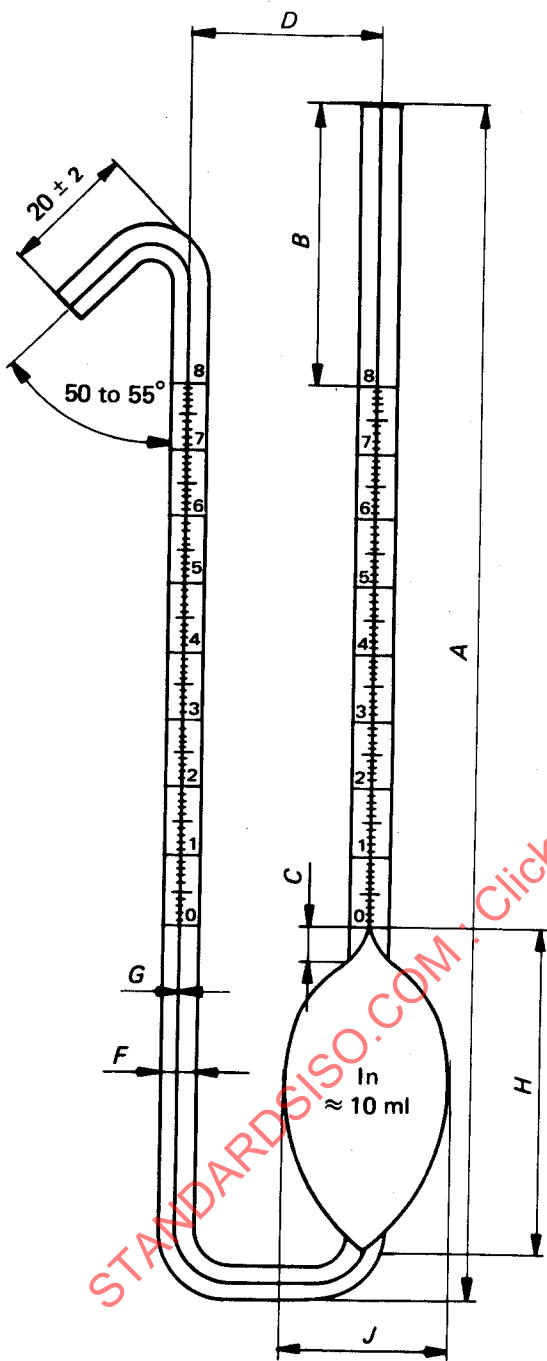


FIGURE 1 – Type 1 (Lipkin)

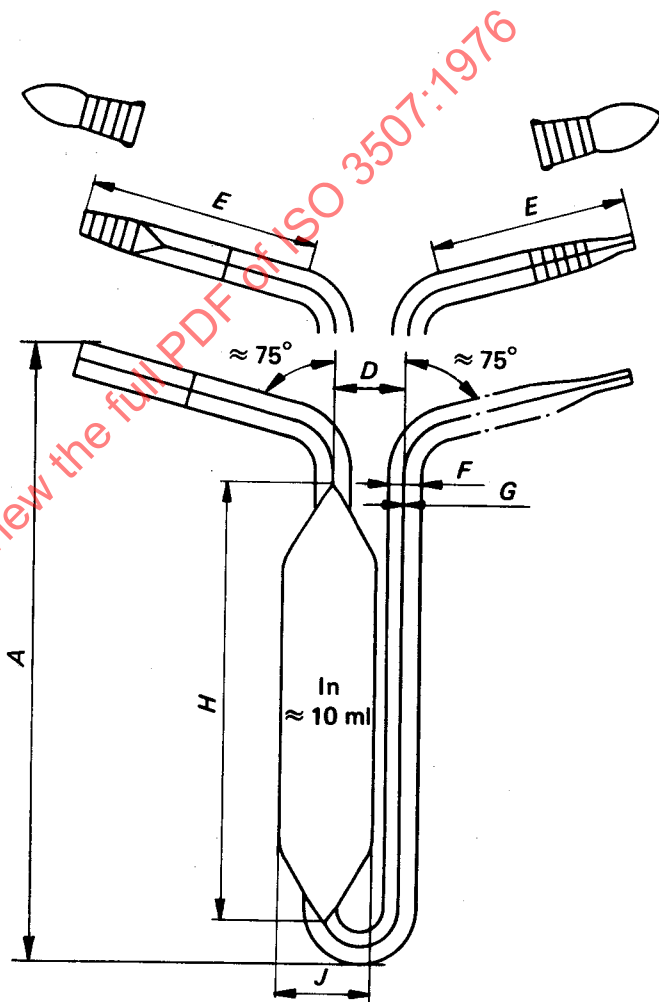


FIGURE 2 – Type 2 (Sprengel)

PYKNOMETER FLASKS

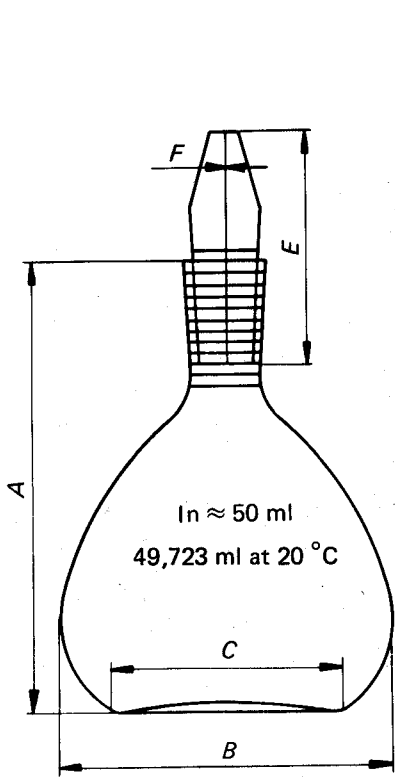


FIGURE 3 — Type 3 (Gay-Lussac)

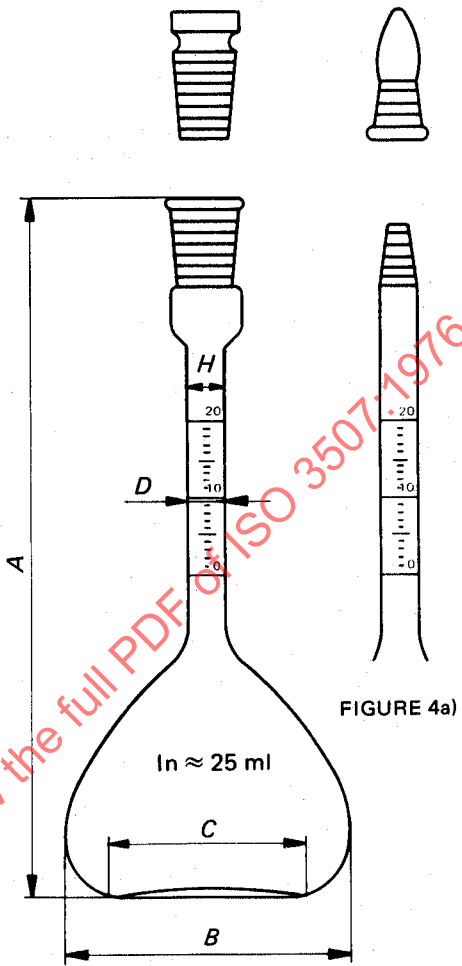


FIGURE 4 — Type 4 (Reischauer)

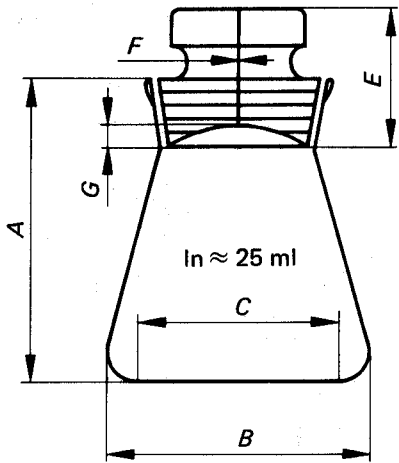


FIGURE 5 — Type 5 (Hubbard)

TABLE 3 — Dimensional requirements for pyknometer flasks (see 6.3)

Characteristic	Type 3 (Gay-Lussac)			Type 4 (Reischauer)		Type 5 (Hubbard)
	(see figure 3)			(see figure 4)		(see figure 5)
Nominal capacity, ml	10	25	50	25	50	25
Difference between actual capacity and nominal capacity, max., ml	± 1	± 2	± 3	± 2	± 3	± 2
Maximum mass including stopper, g	25	30	35	25	30	40
Height to top of neck, <i>A</i> , mm	40	55	65	95	105	43
Diameter of body, <i>B</i> ¹⁾ , mm	27	40	50	40	50	40
Diameter of base, <i>C</i> ¹⁾ , mm	18	27	35	27	35	28
External diameter of neck, <i>D</i> , mm	—	—	—	6	6	—
Height of stopper, <i>E</i> , mm	25	33	33	—	—	22
Bore of stopper, <i>F</i> , mm	1 ± 0,3	1 ± 0,3	1 ± 0,3	—	—	1,6 ± 0,3
Depth of concavity in stopper, <i>G</i> , mm	—	—	—	—	—	5 ± 1
Internal diameter of neck, <i>H</i> , mm	—	—	—	2,2 to 3,8	2,2 to 3,8	—
Top end diameter of neck grinding, mm	7 ± 1	10 ± 1	10 ± 1	—	—	—
Minimum length of engagement of stopper in neck ²⁾ , mm	11	13	13	—	—	—
Neck socket grinding ³⁾	—	—	—	10/13	10/13	24/10
Neck cone grinding [alternative design, see figure 4a)]	—	—	—	5/9	5/9	—

1) These dimensions are appropriate to the preferred shapes of pyknometers illustrated in figures 3 to 5 but may vary if other suitable patterns are used.

2) Interchangeable grinding is not suitable for the neck and stopper of type 3.

3) In accordance with ISO 383.