International Standard ISO 6706

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Plastics laboratory ware — Graduated measuring cylinders

Matériel de laboratoire en plastique — Éprouvettes graduées cylindriques

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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 6706 was developed by Technical Committee ISO/TC 48, *Laboratory glassware and related apparatus*, and was circulated to the member bodies in October 1979.

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

Australia	Italy	Romania
Brazil	Korea, Rep. of	South Africa, Rep. of
Canada	Libyan Arab Jamahiriya	Spain
France	Mexico	United Kingdom
Germany, F. R.	Netherlands	USSR
Hungary	Poland	
India	Portugal	

No member body expressed disapproval of the document.

Plastics laboratory ware — Graduated measuring cylinders

1 Scope and field of application

This International Standard specifies requirements for a series of plastics cylinders having a graduated volumetric scale and a pouring spout.

NOTE — Cylinders may also be provided with two scales.

2 References

ISO 384, *Laboratory glassware — Principles of design and construction of volumetric glassware.*

ISO 649/2, *Laboratory glassware — Density hydrometers for general purposes — Part 2 : Test methods and use.*[1)]

IEC Publication 335/1, *Safety of household and similar electrical appliances — Part 1 : General requirement.*

3 Basis of adjustment

3.1 Unit of volume

The unit of volume shall be the cubic centimetre (cm^3), for which the name millilitre (ml) may be used.

NOTE — The term millilitre (ml) is commonly used as a special name for the cubic centimetre (cm^3), in accordance with the International System of Units (SI).

3.2 Reference temperature

The standard reference temperature, i.e. the temperature at which the cylinder is intended to contain its nominal volume (nominal capacity), shall be 20 °C.

NOTE — When the cylinder is required for use in a country which has adopted a standard reference temperature of 27 °C (the alternative recommended in ISO 384 for tropical use), this figure shall be substituted for 20 °C.

4 Series of nominal capacities

The series of nominal capacities of graduated measuring cylinders shall be as shown in table 1.

Table 1 — Series of capacities, divisions and tolerances

Nominal capacity	Smallest division	Maximum permitted error	Maximum ungraduated capacity at base
ml	ml	ml	ml
10	0,1	± 0,1	1
10	0,2	± 0,2	1
25	0,5	± 0,5	2,5
50	1	± 1	5
100	1	± 1	10
250	2	± 2	24
500	5	± 5	50
1 000	10	± 10	100
2 000	20	± 20	200
4 000	50	± 50	400

5 Definition of capacity

The capacity corresponding to any graduation line shall be defined as the volume of water at 20 °C, expressed in millilitres, contained by the cylinder at 20 °C when filled to that graduation line in accordance with the procedure given in clause A.1 of annex A.

NOTE — Where, exceptionally, the reference temperature is 27 °C, this value shall be substituted for 20 °C.

6 Accuracy

There shall be one class of accuracy.

When tested in accordance with annex A, the errors in capacity shall not exceed the maximum permitted errors shown in table 1. The error represents the maximum permissible error at any point and also the maximum permissible difference between the errors at any two points.

1) At present at the stage of draft. (Revision of ISO/R 649.)

7 Material

7.1 General

Cylinders shall be rigid and shall be constructed of generally non-brittle translucent or transparent plastics material of suitable chemical and thermal properties and shall be as free as possible from moulding defects and stress.

7.2 Resistance to extraction of ionic material by water at 20 °C

When tested in accordance with the procedure given in annex B, the cylinder shall give an aqueous extract, free of suspended matter, and the difference between its conductivity and that of the original water used for the extraction shall not exceed the values given in table 4.

NOTE — The equivalent to the conductivity of water containing approximately 1 mg/l of sodium chloride is 200 µS/m.

Table 2 — Dimensions

Nominal capacity	Internal height to highest graduation line min.	Overall height max.	Distance from highest graduation line to top of cylinder min.
ml	mm	mm	mm
10	90	150	20
25	90	170	20
50	115	200	25
100	145	260	25
250	200	340	35
500	250	390	40
1 000	315	470	40
2 000	400	570	60
4 000	460	585	75

8 Construction (see figure 1)

8.1 Stability

The cylinder shall stand vertically without rocking or spinning when placed on a level surface. It shall not topple when placed empty on a non-slip surface inclined at an angle of 12 ± 1° to the horizontal.

8.2 Base

The base shall be of a suitable plastics material and may or may not be integral with the body. It may be either polygonal with five or more equal sides or circular.

8.3 Spout

The spout shall be so formed as to enable the contents of the cylinder to be poured out in a narrow stream without spilling or running down the outside of the cylinder.

8.4 Dimensions

8.4.1 Cylinders shall comply with the dimensional requirements shown in table 2.

8.4.2 The wall thickness shall be such that when tested for flexibility in accordance with the procedure specified in annex C, the diameter of the cylinder shall not decrease by more than 10 % and the change in indication arising from any permanent distortion caused by the test procedure shall not result in the maximum permitted error given in table 1 being exceeded.

8.5 Translucency

The cylinder shall be constructed in such a manner that when containing transparent liquids, the meniscus can be seen through the cylinder wall.

9 Graduation and figuring (see figures 2 and 3)

9.1 Graduation lines

Graduation lines shall be clean, durable, uniform lines of thickness not exceeding 0,3 mm for capacities up to and including 250 ml, not exceeding 0,7 mm for capacities of 500 ml and 1 000 ml, and not exceeding 1 mm for capacities of 2 000 ml and 4 000 ml.

9.2 Spacing of graduation lines

There shall not be evident irregularity in the spacing of the graduation lines.

9.3 Length of graduation lines

9.3.1 The length of the short lines shall be between 10 % and 12,5 % of the circumference of the cylinder.

9.3.2 The length of the medium lines shall be approximately 1,5 times the length of the short lines.

9.3.3 The length of the long lines shall be not less than twice the length of the short lines.

9.3.4 The medium and long lines shall extend symmetrically at each end beyond the ends of the short lines.

9.4 Sequence of graduation lines

9.4.1 On cylinders of capacity 10 ml divided in 0,1 ml, capacities 50 ml and 100 ml divided in 1 ml, and capacity 1 000 ml divided in 10 ml :

a) every tenth graduation line shall be a long line;

b) there shall be a medium line midway between two consecutive long lines;

c) there shall be four short lines between consecutive medium and long lines.

9.4.2 On cylinders of capacity 10 ml divided in 0,2 ml, capacity 250 ml divided in 2 ml, and capacity 2 000 ml divided in 20 ml :

a) every fifth graduation line shall be a long line;

b) there shall be four short lines between two consecutive long lines.

9.4.3 On cylinders of capacity 25 ml divided in 0,5 ml, capacity 500 ml divided in 5 ml, and 4 000 ml divided in 50 ml :

a) every tenth graduation line shall be a long line;

b) there shall be four medium lines equally spaced between two consecutive long lines;

c) there shall be one short line between two consecutive medium lines and between consecutive medium and long lines.

9.5 Position of graduation lines

The graduation lines shall lie in planes at right angles to the longitudinal axis of the cylinder and shall form a vertical scale on the cylinder on the side facing the viewer when the cylinder is positioned with the spout facing to the left.

9.6 Figuring of graduation lines

Graduation lines shall be figured as illustrated in figures 2 and 3, in accordance with the following principles.

NOTE — If a cylinder is provided with two scales, these provisions apply to both scales.

9.6.1 The scheme of figuring shall be such that the figure representing the nominal capacity refers to the highest graduation line.

9.6.2 The figures shall either be placed slightly to the right of the end of the line to which they refer in such a way that an extension of the line would bisect them, or be placed immediately above the long lines to which they refer and slightly to the right of the adjacent shorter lines.

If the long lines are extended so as almost to encircle the cylinder, either the figures shall be placed immediately above the line or there shall be a break in each long line, slightly to the right of the right-hand ends of the shorter lines, and the figures for that line shall occupy the break, and be placed in such a manner that the line would bisect them.

10 Inscriptions

The following inscriptions shall be durably and legibly marked on all cylinders :

a) the symbol "cm^3" or the symbol "ml" to indicate the unit of volume (see note to 3.1);

b) the inscription "In 20 °C" to indicate that the cylinder is graduated for content at 20 °C;

NOTE — Where, exceptionally, the reference temperature is 27 °C, this value should be substituted for 20 °C.

c) the maker's and/or vendor's name or readily identifiable mark;

d) the name or an abbreviation of the name of the material from which the body of the cylinder is made, for example "PP";

e) the number of this International Standard, or the number of the relevant national standard.

Annex A

Testing of plastics measuring cylinders

(This annex forms an integral part of the Standard.)

A.1 Thoroughly clean and dry the measuring cylinder. Fill the clean weighed cylinder with distilled water to a few millimetres above the graduation mark to be tested, taking care to avoid wetting the cylinder above the water surface. Ensure that the cylinder settles down to room temperature before testing, and determine the water temperature, t °C. Adjust the lowest point of the water meniscus to the top edge of the graduation mark in question by withdrawing small amounts of water by means of a glass tube drawn out to a jet at its lower end.

If the meniscus is curved, set it so that the plane of the upper edge of the graduation line is horizontally tangential to the lowest point of the meniscus, the line of sight being in the same plane.

Determine the mass of the water in the cylinder. Calculate the volume of water at 20 °C contained by the cylinder up to the graduation mark tested from the mass thus determined by applying a correction for water temperature as described in clause A.2.

A.2 Obtain the capacity in millilitres of the plastics measuring cylinder at 20 °C, by multiplying the mass, in grams, of pure water contained at t °C by the factor $(1 + c)$.

The quantity c is given in table 3 in units of 10^{-5} ml/g for plastics materials having various values for the coefficient of cubical thermal expansion.

NOTE — Manufacturers should be consulted for the appropriate value for this coefficient. The value can be obtained by linear interpolation in the table.

The values of c given in the table are applicable at a barometric pressure of 1,013 bar and a temperature of 20 °C. When large deviations from these values occur, it may be necessary to take account of second-order effects arising from changes in the buoyancy correction caused by variations in atmospheric pressure and temperature, and these may be obtained from appropriate tables.

Table 3 — Values of the quantity c in units of 10^{-5} ml/g used in calibration

Temperature	Coefficient of cubical thermal expansion of the plastics material in units of 10^{-5} (°C)$^{-1}$				
°C	20	30	40	50	60
5	410	561	713	865	1 018
6	392	533	675	817	959
7	376	507	638	770	902
8	361	482	603	725	846
9	348	459	570	681	792
10	336	437	537	639	738
11	325	416	507	598	689
12	316	397	477	558	639
13	308	379	449	520	590
14	301	362	422	483	543
15	296	346	396	447	497
16	292	332	372	412	452
17	288	319	349	379	409
18	286	306	327	347	367
19	285	296	306	316	326
20	286	286	286	286	286
21	287	277	267	257	247
22	289	269	249	229	209
23	292	262	232	202	172
24	297	257	217	177	137
25	302	252	202	152	102
26	308	248	188	128	68
27	316	246	176	106	36
28	324	244	164	84	4
29	333	243	153	63	− 27
30	343	243	143	43	− 56
31	354	244	134	24	− 85
32	365	245	126	6	− 113
33	378	248	118	− 11	− 140
34	392	252	112	− 27	− 166
35	406	256	106	− 43	− 191

Basis of table

When a quantity of water at t °C is weighed in air, equilibrium is given by the formula

$$m_{\mathrm{w}} - \frac{m_{\mathrm{w}}}{\varrho_{\mathrm{b}t}} \varrho_{\mathrm{a}t} = V_t \varrho_{\mathrm{w}t} - V_t \varrho_{\mathrm{a}t} \qquad \ldots (1)$$

where

m_{w} is the apparent mass, in grams, of the water in air;

$\varrho_{\mathrm{a}t}$ is the density, in grams per cubic centimetre, of the air at the time of weighing (taken as $1{,}199\,4 \times 10^{-3}$ g/cm^3);

$\varrho_{\mathrm{b}t}$ is the density, in grams per cubic centimetre, of the balance weights at the time of weighing (taken as 8,0 g/cm^3);

V_t is the volume, in cubic centimetres, of the water at t °C;

$\varrho_{\mathrm{w}t}$ is the density, in grams per cubic centimetre, of the water at t °C (derived from ISO 649/2).

If γ is the coefficient of cubical thermai expansion of the plastics material, then

$$V_t = V_{20} [1 + \gamma (t - 20)] \qquad \ldots (2)$$

Eliminating V_t from equations (1) and (2) leads to

$$1 + c = \frac{1 - \varrho_{\mathrm{a}t}/\varrho_{\mathrm{b}t}}{(\varrho_{\mathrm{w}t} - \varrho_{\mathrm{a}t})\,[1 + \gamma (t - 20)]} = \frac{V_{20}}{m_{\mathrm{w}}}$$

Annex B

Test for ionic material extracted by water at 20 °C

(This annex forms an integral part of the Standard.)

B.1 Apparatus and materials

B.1.1 Clock glasses, made of borosilicate glass, sizes appropriate to the cylinders under test.

B.1.2 Conductivity meter, suitable for measurement of the electrical conductivity of water.

B.1.3 De-ionized water, the conductivity of which is less than 200 µS/m.

B.1.4 Detergent solution.

B.2 Procedure

Thoroughly wash the cylinder under test with hot water and detergent solution (B.1.4), then rinse well with hot, followed by cold water, and finally with liberal quantities of de-ionized water (B.1.3). Fill the cylinder to its nominal capacity with de-ionized water at 20 ± 2 °C. Cover with a clean clock glass (B.1.1) and allow to stand for 3 h.

Measure the electrical conductivity of the extract by an appropriate procedure and deduct from the value obtained the conductivity of the original water used to prepare the extract, also measured at 20 °C. Note the difference in conductivity in microsiemens per metre.

Table 4 — Maximum permitted difference in conductivity

Nominal capacity	Conductivity difference
ml	µS/m
10	600
25	400
50	300
100	250
250	200
500	150
1 000	100
2 000	100
4 000	80

Annex C

Flexibility and recovery test for plastics cylinders

(This annex forms an integral part of the Standard.)

C.1 Apparatus (see figure 4)

C.1.1 Square blocks of wood, up to 29 in number, each 19 mm thick, having a square with sides up to 110 mm cut from one corner and not exceeding one quarter of the original block.

C.1.2 Test pin, complying with the requirements of IEC Publication 335/1.

C.1.3 Guide for the test pin, consisting of a stout plate with a 13 mm diameter hole, adjustable in distance (from 10 to 200 mm) from the inside corner of the blocks and adjustable in height (from 60 to 300 mm).

C.1.4 Thermometer, covering the range from − 5 °C to + 105 °C, graduated at each degree Celsius.

C.1.5 Inside calipers, opening from 10 to 100 mm.

C.1.6 G-clamp.

C.1.7 Tongs or holding device for introducing calipers into the measuring cylinder.

C.2 Procedure

C.2.1 Stack sufficient of the L-shaped wooden blocks (C.1.1) to bring the highest just below the brim of the measuring cylinder to be tested.

C.2.2 Adjust the blocks so that the lower ones accommodate the base of the measuring cylinder and each of the others touches the measuring cylinder at two points. Then clamp the stack to the working surface using the G-clamp (C.1.6).

C.2.3 Adjust the brackets bearing the guide (C.1.3) so that the test pin (C.1.2), when inserted through the hole, will touch the measuring cylinder at a height equal to half of the total height of the measuring cylinder.

C.2.4 Adjust the brackets or other fixing bearing the guide so that it is fixed 20 mm from the measuring cylinder.

C.2.5 Place the assembly in an enclosure maintained at 20 ± 2 °C, and by using the calipers (C.1.5), measure the inside diameter (d mm) of the measuring cylinder at the point of application and in the direction of the force to be applied. Set the callipers at 0,9 d mm.

C.2.6 Insert the test pin and apply a steady force of 30 N as shown by the force indicator of the test pin, horizontally and towards the axis of the measuring cylinder.

C.2.7 If, after the force has been applied for 60 s and is still maintained, the calipers cannot be positioned inside the measuring cylinder at the point of application and in the direction of the applied force, then the diameter has decreased by more than 10 % and the cylinder has failed the test.

C.2.8 Remove the test pin.

C.2.9 Rotate the measuring cylinder through 90° and repeat from C.2.5 to C.2.8.

C.2.10 Fill the measuring cylinder to just below its nominal capacity with water at 20 ± 2 °C and note the exact reading (V_1 ml).

C.2.11 Repeat C.2.6.

C.2.12 After the force has been applied for 60 s, remove the test pin, wait a further 60 s, read the volume of the water (V_2 ml), and record the difference ($V_2 - V_1$) ml arising from any permanent distortion.

C.2.13 Compare the difference ($V_2 - V_1$) ml with the appropriate value of the maximum permitted error given in table 1.