International Standard 4801

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

Glass alcoholometers and alcohol hydrometers not incorporating a thermometer

Alcoomètres et aréomètres pour alcool, sans thermomètre incorporé

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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 4801 was developed by Technical Committee ISO/TC 48, *Laboratory glassware and related apparatus*, and was circulated to the member bodies in November 1977.

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

Australia	India	South Africa, Rep. of
Brazil	Israel	Spain
Czechoslovakia	Italy	Turkey
Egypt, Arab Rep. of	Mexico	United Kingdom
France	Netherlands	USSR
Germany, F.R.	Poland	Yugoslavia
Hungary	Romania	

The member body of the following country expressed disapproval of the document on technical grounds :

USA

Printed in Switzerland

Glass alcoholometers and alcohol hydrometers not incorporating a thermometer

1 SCOPE AND FIELD OF APPLICATION

This International Standard sets forth the requirements for three different types of glass instrument, not incorporating a thermometer, suitable for the accurate determination of the ethanol content of simple mixtures of ethanol and water, namely

— type 1 : alcoholometers graduated in percentage of ethanol by volume at 20 °C;

— type 2 : alcoholometers graduated in percentage of ethanol by mass;

— type 3 : alcohol hydrometers graduated in units of density (kilograms per cubic metre) at 20 °C.

Two classes of accuracy are specified for types 1 and 2 and one class for type 3.

Alcoholometers and alcohol hydrometers with an incorporated thermometer are dealt with in ISO 4805[1)].

2 DEFINITIONS

2.1 alcoholometer : An instrument which indicates

— the alcoholic strength by mass, or

— the alcoholic strength by volume,

of a mixture of water and ethanol.

2.2 alcohol hydrometer : An instrument designed to measure the density of a mixture of water and ethanol.

2.3 ethanol content of an ethanol-water mixture as a percentage by volume [% (*V/V*)] **at 20 °C :** The number of volumes of ethanol at 20 °C required to form 100 volumes of that mixture at 20 °C.

NOTE — In countries where the relevant regulations require it, the expression "% vol" may replace the expression "% (*V/V*)".

2.4 ethanol content of an ethanol-water mixture as a percentage by mass [% (*m/m*)] **:** The number of units of mass of ethanol required to form 100 units of mass of that mixture.

NOTE — In countries where the relevant regulations require it, the expression "% mass" may replace the expression "% (*m/m*)".

1) At present at the stage of draft.

2.5 density of an ethanol-water mixture at 20 °C : The mass of unit volume of the mixture at 20 °C. It is expressed in kilograms per cubic metre.

3 BASIS OF SCALE

The basis of the scale of each type of instrument is as follows :

— Type 1 alcoholometers : ethanol content as a percentage by volume at 20 °C.

— Type 2 alcoholometers : ethanol content as a percentage by mass.

— Type 3 alcohol hydrometers : density at 20 °C.

The basis of the scales of the type 1 and type 2 hydrometers shall be the tables of density versus composition of ethanol solution published with the approval of the International Organization of Legal Metrology.

4 CLASSIFICATION

Two classes of accuracy are specified, as shown in table 1.

TABLE 1 — **Classes of accuracy**

Class	Minimum mean distance between centres of adjacent graduation lines mm	Type
1	1,5	1, 2, 3
2	1,05	1, 2

5 REFERENCE TEMPERATURE

The reference temperature for all three types of instrument shall be 20 °C.

6 REFERENCE LEVEL FOR READING

The instruments shall be graduated for reading at the level of the free horizontal surface of the liquid.

7 DESCRIPTION

7.1 Each instrument shall consist of a cylindrical body whose lower end is of such a form (preferably conical) as will effectively prevent the entrapment of air bubbles.

7.2 At its upper end, the body shall be fused on to a hollow cylindrical stem. The top end of the stem shall be sealed.

7.3 The shape of the instrument shall be symmetrical about its longitudinal (vertical) axis. Its cross-section shall not exhibit any abrupt variations.

7.4 The loading material for adjusting the mass of the instrument shall be contained in the lower part of the body.

7.5 There shall be no loose material in any part of the instrument.

7.6 The stem shall contain a graduated scale, marked on a strip of suitable material (see 10.1.2, 10.1.3 and 10.1.4) which shall be securely fastened to the interior of the stem. Datum marks (reference marks) shall be provided on the strip and on the stem in order that any displacement of the former relative to the latter would be readily apparent.

7.7 The instrument shall float with its axis vertical to within 1,5° of arc.

8 MATERIALS AND WORKMANSHIP

8.1 The instrument shall be constructed from soda-lime glass which shall be transparent, free from stress (i.e. properly annealed) and free from flaws such as would obscure or alter the reading of the scale.

8.2 The coefficient of cubical thermal expansion of the glass shall be $(25 \pm 2) \times 10^{-6}\ °C^{-1}$.*

8.3 The loading material shall be fixed in the bottom part of the instrument. After the finished instrument has been kept in a horizontal position for 1 h at 80 °C and subsequently cooled to room temperature in that position, the instrument shall meet the requirements of 7.7.

Mercury shall not be used as the loading material.

9 DIMENSIONS

9.1 The dimensions of the instruments shall be as detailed in table 2.

9.2 The cross-section of the stem shall remain unchanged for at least 5 mm below the lowest graduation line of the scale.

9.3 The stem shall extend by at least 15 mm above the uppermost graduation line of the scale.

10 SCALE

10.1 General

10.1.1 The instrument shall not have more than one scale.

10.1.2 The scale and the inscriptions shall be marked on a strip having a smooth matt surface of white or off-white colour. The graduations within the nominal scale limits and the inscriptions shall be marked in black. Graduations outside the nominal scale limits (see 10.2.4) may be marked in a colour other than black.

10.1.3 The strip bearing the scale shall be of cylindrical form straight and free from twist.

10.1.4 The strip shall show no evidence of charring. The strip bearing the scale shall not become discoloured or distorted when the stem is maintained for 24 h at a temperature of 70 °C.

10.2 Graduation lines (scale marks)

10.2.1 The graduation lines shall lie in planes perpendicular to the axis of the stem. They shall be distinct and of uniform thickness not exceeding one-fifth of the distance between the centres of adjacent graduation lines or 0,2 mm, whichever is less.

10.2.2 The short, medium and long graduation lines shall extend, respectively to at least one-fifth, one-third and one-half of the circumference of the stem. (See the figure.)

10.2.3 There shall be no evident local irregularity in the spacing of the graduation lines.

NOTE – If an instrument does not comply with this requirement, the testing authority may avoid unnecessary testing for compliance with the requirements of clause 12.

10.2.4 The nominal range of each instrument shall not exceed 10 % (*m/m*) (10 % mass) for type 1, 10 % (*V/V*) (10 % vol) for type 2 and 20 kg/m^3 for type 3. Each instrument shall carry five to ten additional graduation lines beyond the nominal limits at both ends of its scale, but for type 3 instruments there shall be no lines beyond 1 000 kg/m^3.

* This value complies with ISO 1768, *Glass hydrometers – Conventional value for the thermal cubic expansion coefficient (for use in the preparation of measurement tables for liquids).*

10.3 Sequence of graduation lines

10.3.1 *Types 1 and 2*

Each graduation line corresponding to a whole unit per cent of ethanol shall be a long line. There shall be a medium line at each half per cent of ethanol, and four short lines, corresponding to tenths of one per cent, between each long line and each medium line.

All the long lines shall be numbered in full. The short lines shall not be numbered.

10.3.2 *Type 3*

10.3.2.1 Each graduation line corresponding to a whole unit (kg/m^3) shall be a long line. There shall be four short lines corresponding to intervals of 0,2 kg/m^3 between two consecutive long lines.

10.3.2.2 All the long lines shall be numbered, and (with the exception of the nominal scale limits) may be partially numbered if required. The short lines shall not be numbered.

10.4 Visibility of graduation lines and figures

The scale shall be numbered so as to enable the value corresponding to any graduation line to be readily and unambiguously identified.

11 SURFACE TENSION

In marking the graduation lines, the conventional values given in tables 3 and 4 shall be assumed for the surface tension at 20 °C of ethanol solutions of various concentrations.

NOTES

1 The values given in tables 3 and 4 are based on values adopted by the International Organization of Legal Metrology.

2 In tables 3 and 4 the entries for values exceeding 100 % are theoretical values required for the determination of the ethanol content of certain mixtures at temperatures above 20 °C.

12 MAXIMUM PERMISSIBLE ERROR AND TESTING

The maximum permissible error shall be half a scale division for class 1 instruments and one scale division for class 2 instruments.

When an instrument is tested for compliance with this requirement, at least three points evenly distributed over the whole length of the nominal scale shall be tested.

13 DETERMINATION OF TEMPERATURE

An International Standard concerning thermometers for the determination of sample temperature, required during the use of the instruments, is in preparation.

14 INSCRIPTIONS

14.1 The following information shall be legibly and indelibly marked inside each instrument :

a) the basis of the scale and the standard temperature, for example "% (*V/V*); 20 °C" or "% (*m/m*); 20 °C" or "kg/m^3; 20 °C";

b) the word "ethanol";

c) the accuracy class of the instrument, for example "class 2";

d) the maker's name or readily identifiable mark;

e) the serial number of the instrument, the last two digits of which shall indicate the year of manufacture;

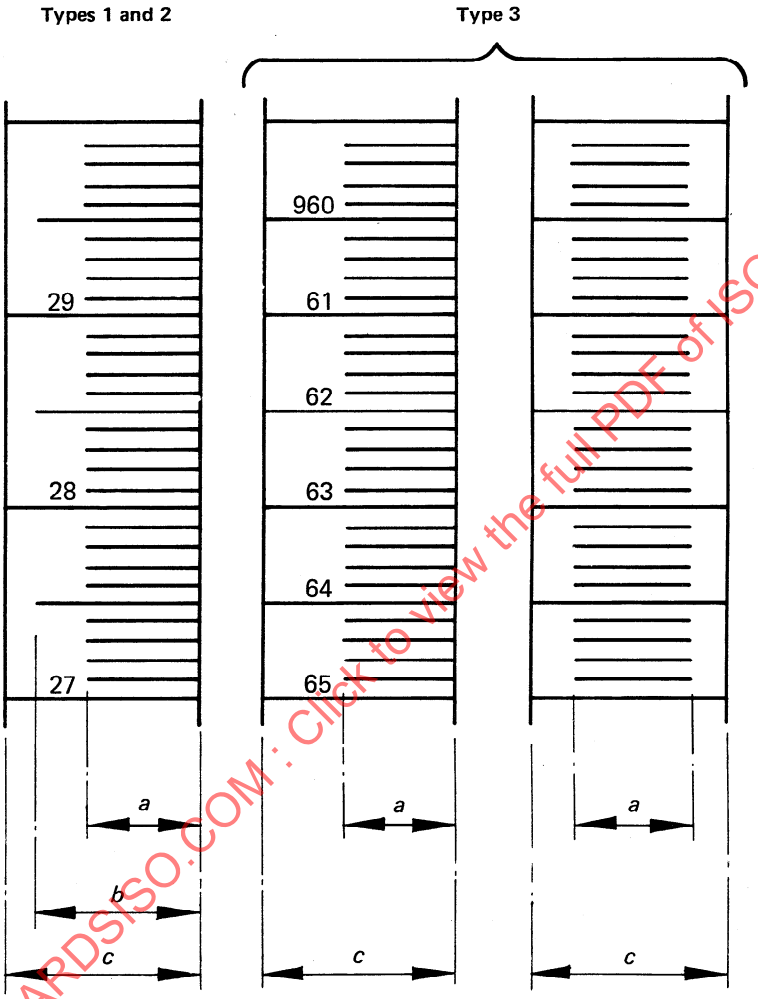
f) the number of this International Standard or of the corresponding national standard with which compliance is claimed.

14.2 The following additional information may also be marked on the instrument :

g) the mass of the instrument;

NOTE — In countries where the relevant regulations require an inscription for the mass of a particular alcoholometer, this inscription should be to the nearest 0,001 g.

h) in countries where the relevant regulations require it, and with the consent of the appropriate pattern approval agency, a pattern approval sign.



Minimum line lengths :

$a \geqslant 0{,}2\ U$

$b \geqslant 0{,}33\ U$

$c \geqslant 0{,}5\ U$

where U is the stem circumference

FIGURE — **Types of graduation and lengths of graduation lines**

TABLE 2 — Requirements

Class	Type	Range	Maximum total length	Scale sub-division	Tolerance at any point	Body diameter		Volume below scale		Minimum stem diameter
						min.	max.	min.	max.	
		% (*V*/*V*), % (*m*/*m*) or kg/m^3	mm	% (*V*/*V*), % (*m*/*m*) or kg/m^3	% (*V*/*V*), % (*m*/*m*) or kg/m^3	mm		ml		mm
1	1, 2	0/10 10/20 20/30 30/40 40/50 50/60	400	0,1	± 0,05	36	38	160	180	3,5
		60/70 70/80	400	0,1	± 0,05	32	36	130	150	3,5
		80/90 90/100	400	0,1	± 0,05	26	28	65	85	3,5
2	1, 2	0/10 10/20 20/30 30/40 40/50 50/60	340	0,1	± 0,1	32	36	120	140	3
		60/70 70/80	340	0,1	± 0,1	28	30	90	110	4
		80/90 90/100	340	0,1	± 0,1	23	27	50	65	4
	3	780/800 800/820 up to 960/980 980/1 000	300	0,2	± 0,2	36	40	95	125	4

TABLE 3 — **Ethanol content by mass, density and surface tension at 20 °C**

Ethanol content	Density	Surface tension	Ethanol content	Density	Surface tension	Ethanol content	Density	Surface tension
% (*m*/*m*) (or % mass)	kg/m^3	mN/m	% (*m*/*m*) (or % mass)	kg/m^3	mN/m	% (*m*/*m*) (or % mass)	kg/m^3	mN/m
0	998,20	72,6	40	935,15	29,9	80	843,39	24,8
1	996,31	67,4	41	933,10	29,7	81	840,91	24,7
2	994,49	63,0	42	931,03	29,5	82	838,43	24,6
3	992,73	60,1	43	928,94	29,3	83	835,93	24,5
4	991,02	57,8	44	926,82	29,1	84	833,41	24,4
5	989,38	55,7	45	924,69	28,9	85	830,88	24,3
6	987,78	53,8	46	922,53	28,8	86	828,32	24,2
7	986,24	52,1	47	920,37	28,6	87	825,75	24,1
8	984,73	50,5	48	918,18	28,5	88	823,15	24,0
9	983,27	49,1	49	915,98	28,3	89	820,53	23,8
10	981,85	47,8	50	913,77	28,2	90	817,88	23,7
11	980,46	46,6	51	911,55	28,1	91	815,21	23,6
12	979,10	45,5	52	909,31	28,0	92	812,49	23,5
13	977,76	44,4	53	907,07	27,8	93	809,75	23,4
14	976,44	43,4	54	904,81	27,7	94	806,97	23,2
15	975,13	42,5	55	902,55	27,6	95	804,14	23,1
16	973,83	41,6	56	900,28	27,5	96	801,27	23,0
17	972,54	40,7	57	897,99	27,3	97	798,36	22,8
18	971,24	39,9	58	895,70	27,2	98	795,38	22,7
19	969,93	39,1	59	893,40	27,1	99	792,35	22,6
20	968,61	38,3	60	891,10	27,0	100	789,24	22,4
21	967,27	37,7	61	888,78	26,9	101	786,13	22,3
22	965,90	37,0	62	886,46	26,8	102	783,02	22,2
23	964,51	36,4	63	884,13	26,7	103	779,91	22,1
24	963,09	35,8	64	881,79	26,6	104	776,80	22,0
25	961,63	35,2	65	879,45	26,5	105	773,69	21,9
26	960,14	34,7	66	877,09	26,4	106	770,58	21,8
27	958,61	34,2	67	874,73	26,3			
28	957,05	33,7	68	872,37	26,2			
29	955,44	33,3	69	869,99	26,1			
30	953,78	32,8	70	867,61	26,0			
31	952,09	32,5	71	865,22	25,8			
32	950,36	32,1	72	862,83	25,7			
33	948,58	31,8	73	860,43	25,6			
34	946,77	31,4	74	858,02	25,5			
35	944,92	31,1	75	855,60	25,4			
36	943,03	30,9	76	853,17	25,3			
37	941,11	30,6	77	850,74	25,2			
38	939,15	30,3	78	848,30	25,1			
39	937,16	30,1	79	845,85	25,0			

TABLE 4 — **Ethanol content by volume, density and surface tension at 20 °C**

Ethanol content	Density	Surface tension	Ethanol content	Density	Surface tension	Ethanol content	Density	Surface tension
% (*V*/*V*) (or % vol)	kg/m^3	mN/m	% (*V*/*V*) (or % vol)	kg/m^3	mN/m	% (*V*/*V*) (or % vol)	kg/m^3	mN/m
0	998,20	72,6	35	955,59	33,3	70	885,56	26,7
1	996,70	68,1	36	954,15	32,9	71	883,06	26,6
2	995,23	64,5	37	952,69	32,6	72	880,54	26,5
3	993,81	61,7	38	951,18	32,3	73	877,99	26,4
4	992,41	59,6	39	949,63	31,9	74	875,40	26,3
5	991,06	57,8	40	948,05	31,7	75	872,79	26,2
6	989,73	56,1	41	946,42	31,4	76	870,15	26,1
7	988,43	54,5	42	944,76	31,1	77	867,48	25,9
8	987,16	53,1	43	943,06	30,9	78	864,78	25,8
9	985,92	51,8	44	941,32	30,6	79	862,04	25,7
10	984,71	50,5	45	939,54	30,4	80	859,27	25,6
11	983,52	49,4	46	937,73	30,2	81	856,46	25,4
12	982,35	48,3	47	935,88	30,0	82	853,62	25,3
13	981,21	47,2	48	934,00	29,8	83	850,74	25,2
14	980,08	46,3	49	932,09	29,6	84	847,82	25,0
15	978,97	45,4	50	930,14	29,4	85	844,85	24,9
16	977,87	44,5	51	928,16	29,3	86	841,84	24,8
17	976,79	43,7	52	926,16	29,1	87	838,77	24,6
18	975,71	42,9	53	924,12	28,9	88	835,64	24,5
19	974,63	42,1	54	922,06	28,8	89	832,45	24,4
20	973,56	41,4	55	919,96	28,6	90	829,18	24,2
21	972,48	40,7	56	917,84	28,5	91	825,83	24,1
22	971,40	40,0	57	915,70	28,3	92	822,39	23,9
23	970,31	39,3	58	913,53	28,2	93	818,85	23,8
24	969,21	38,7	59	911,33	28,1	94	815,18	23,6
25	968,10	38,1	60	909,11	27,9	95	811,38	23,4
26	966,97	37,5	61	906,87	27,8	96	807,42	23,3
27	965,81	37,0	62	904,60	27,7	97	803,27	23,1
28	964,64	36,4	63	902,31	27,6	98	798,90	22,9
29	963,44	35,9	64	899,99	27,4	99	794,25	22,6
30	962,21	35,4	65	897,65	27,3	100	789,24	22,4
31	960,95	35,0	66	895,28	27,2	101	783,75	22,2
32	959,66	34,5	67	892,89	27,1	102	778,26	22,0
33	958,34	34,1	68	890,48	27,0	103	772,77	21,8
34	956,98	33,7	69	888,03	26,9	104	767,28	21,6