

CONFIRMED
DECEMBER 2007

Specification for

Density hydrometers

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Laboratory Apparatus Standards Policy Committee (LBC/-) to Technical Committee LBC/5, upon which the following bodies were represented:

- British Laboratory Ware Association
- Department of Trade and Industry (Laboratory of the Government Chemist)
- Department of Trade and Industry (National Physical Laboratory)
- Department of Trade and Industry (National Weights and Measures Laboratory)
- Institute of Brewing
- Institute of Petroleum
- National Sulphuric Acid Association
- Royal Society of Chemistry
- Scotch Whisky Association
- Society of Glass Technology

This British Standard, having been prepared under the direction of the Laboratory Apparatus Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 31 May 1991

© BSI 06-1999

First published December 1936
Second edition April 1953
Third edition December 1960
Fourth edition December 1979
Fifth edition 1991

The following BSI references relate to the work on this standard:
Committee reference LBC/5
Draft for comment 90 54510 DC

ISBN 0 580 19529 5

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
Committees responsible	Inside front cover
Foreword	iii
1 Scope	1
2 References	1
3 Basis of scale	1
4 Reference temperature	1
5 Surface tension	1
6 Reference levels for adjustment and reading	1
7 Immersion	1
8 Materials and workmanship	1
9 Form	2
10 Scale	2
11 Ranges of the series of hydrometers	3
12 Principal dimensions	3
13 Maximum permitted instrument errors	4
14 Inscriptions	4
Appendix A Standard categories of surface tension for hydrometers	5
Appendix B Meniscus corrections	6
Appendix C Recommended stem diameters for hydrometers	7
Appendix D Testing of BS hydrometers	8
Appendix E Method for determination of density by means of BS hydrometers	8
Appendix F Table for use in calculating quantities of liquid in bulk	12
Appendix G Vessels for hydrometer observations	13
Appendix H Density of air-free distilled water	13
Appendix J Differences between readings on hydrometers graduated on various bases of scale	16
Figure 1 — Preferred design of hydrometer bulb	2
Figure 2 — Examples of hydrometer scales permitted in clause 10	17
Figure 3 — Overflow vessels suitable for observations on hydrometers	18
Table 1 — Principal requirements for series of hydrometers	4
Table 2 — Maximum permitted instrument errors	4
Table 3 — Standard categories of surface tension	5
Table 4 — Average meniscus corrections expressed in units of density	6
Table 5 — Average meniscus corrections expressed in units of length	7
Table 6 — Recommended stem diameters for hydrometers	7
Table 7 — Corrections for temperature applicable to BS density hydrometers standardized at 20 °C or 15 °C	10
Table 8 — Surface tension corrections	11
Table 9 — Conversion of density (kg/m ³ or g/ml) to apparent mass (in air) in kg or g of the liquid occupying 1 m ³ or 1 ml at a given temperature, <i>t</i>	12
Table 10 — Cylinders complying with the requirements of BS 604 suitable for observations on BS hydrometers	13
Table 11 — Density of air-free distilled water (kg/m ³)	14

	Page
Table 12 — Differences between readings on hydrometers graduated for density at 20 °C or 15 °C or relative density 60/60 °F	16
Publication(s) referred to	Inside back cover

Foreword

This British Standard has been prepared under the direction of the Laboratory Apparatus Standards Policy Committee. It supersedes BS 718:1979 which is withdrawn. BS 718:1979 was undertaken with the following objectives in view.

- a) To align as nearly as practicable with ISO 387 and ISO 649 prepared by Technical Committee 48, Laboratory glassware and related apparatus, of the International Organization for Standardization (ISO).
- b) To restrict the scales of density to the exclusion of relative density (formerly termed specific gravity)¹⁾.
- c) As a step to the full utilization of basic SI units, to introduce the option of scales marked in kg/m³ as an alternative to g/ml.

In addition to the five series and two sub-series of hydrometers specified in the 1960 edition, a new sub-series (S50SP) was introduced which, like the other sub-series, is for use in the petroleum industry.

This edition introduces technical changes but it does not reflect a full review or revision of the standard which will be undertaken in due course.

This edition introduces an additional single range hydrometer in the sub-series particularly for use with petroleum fuels and updates the data for density of water in Appendix H to allow for changes in the International Temperature Scale in ITS-90.

In addition to the specification this standard contains a number of appendices. These include a table of the surface tension categories adopted for the hydrometers, a table of recommended stem diameters, information on the technique for using hydrometers, tables of temperature corrections, indications of the influence of surface tension on the various hydrometers, a table for correcting readings taken at the top of the meniscus in opaque liquids and tables facilitating the measurement of the volume of liquid in bulk on the basis of hydrometer observations²⁾. Suitable vessels for use with the hydrometers are described. The relationship between density and weight per millilitre in air is indicated. A new table for the density of distilled water between 0 °C and 40 °C is included. Information enabling hydrometer and pycnometer readings to be interrelated (given in the 1960 edition of this British Standard) is given in BS 733.

Guide to intending purchasers of British Standard hydrometers

The following notes are provided to assist in the selection of the particular British Standard hydrometers which are the most suitable in any given circumstances. Intending purchasers are advised to state precisely, when enquiring or ordering from suppliers, which of the variants referred to are required. The references on the right are to the relevant portions of the standard.

¹⁾ Users who may have a continuing need to use relative density ($d_{60/60}$ °F) hydrometers should refer to ISO 650 which is technically identical with the relevant parts of the 1953 and 1960 editions of this standard.

²⁾ Attention is drawn to the fact that in the petroleum industry a different method, of special applicability, is in use for the measurement of oil in bulk.

a) Series (which governs the size of the hydrometer and the precision of readings)*Reference*

Series	Nominal range of individual scales		Scale subdivision		Total length
	kg/m ³	g/ml	kg/m ³	g/ml	mm
L20 (long)	20	0.020	0.2	0.000 2	335
L50 or (long)	50	0.050	0.5	0.000 5	335
L50SP					
M50 or (medium)	50	0.050	1.0	0.001	270
M50SP					
M100 (medium)	100	0.100	2.0	0.002	250
S50 (short)	50	0.050	2.0	0.002	190
S50SP (short)	50	0.050	1.0	0.001	190

Table 1 and Table 2

b) Range of hydrometer required. Selection to be made according to application and range required from the 70 hydrometers in series L20, the 28 in series L50, M50 or S50, and the 14 in series M100; or from the 11 covering the range 0.6 g/ml to 1.1 g/ml in sub-series L50SP, M50SP or S50SP.

Clause 11

c) Basis of scale. For sub-series L50SP, M50SP and S50SP only, select density at 15 °C or density at 20 °C.

Clause 3

d) Surface tension category. Select low or medium or high according to the type of liquid and the method of use or for hydrometers of the highest precision, specify the liquid in which they will be used.

Clause 5

e) Special requirements, where unavoidable, in accordance with the particular circumstances. For example, a smaller maximum error than that specified in the standard may be essential; or it may be that the hydrometer will be used at a temperature higher than 70 °C, in which case either the loading material should have a softening point higher than 80 °C, or a hydrometer with mercury loading should be used.

Clause 13

Clause 8

It may also be desired to order special hydrometer jars appropriate to the instruments which are being purchased.

Appendix G

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This British Standard specifies requirements for five basic series of glass hydrometers of constant mass which are graduated to indicate density (kg/m^3 or g/ml) when used at $20\text{ }^\circ\text{C}$.

Each series comprises hydrometers which between them cover the interval 600 kg/m^3 to $2\,000\text{ kg/m}^3$ (0.6 g/ml to 2.0 g/ml). The hydrometers are graduated appropriately for use in liquids of low, medium or high surface tension.

The standard also specifies three sub-series of hydrometers which are graduated either to indicate density when used at $15\text{ }^\circ\text{C}$ or to indicate density when used at $20\text{ }^\circ\text{C}$. They have smaller tolerances on scale error, are limited to the range 600 kg/m^3 to $1\,100\text{ kg/m}^3$ (0.6 g/ml to 1.1 g/ml) and are for use in liquids of low surface tension.

A single hydrometer principally suitable for the measurement of the density of petroleum fuels is included.

This British Standard does not cover hydrometers with a built-in thermometer (thermohydrometers).

2 References

The titles of the publications referred to in this standard are listed on the inside back cover.

3 Basis of scale

3.1 The basis of scale shall be density (mass per unit volume) in kilograms per cubic metre (kg/m^3). The use of grams per cubic centimetre (g/cm^3) or grams per millilitre (g/ml) is accepted.

NOTE The term millilitre (ml) is commonly used as a special name for the cubic centimetre (cm^3), in accordance with a decision of the twelfth Conférence Générale des Poids et Mesures. The term millilitre is acceptable, in general, for reference to capacities of volumetric glassware and is used in the present text.

4 Reference temperature

4.1 The standard reference temperature for density hydrometers excluding the special sub-series L50SP, M50SP and S50SP shall be $20\text{ }^\circ\text{C}$. When used in a liquid at this temperature, the hydrometer shall indicate the density of the liquid at $20\text{ }^\circ\text{C}$.

4.2 The standard reference temperature for density hydrometers of the special sub-series L50SP, M50SP and S50SP shall be either $15\text{ }^\circ\text{C}$ or $20\text{ }^\circ\text{C}$. When used in a liquid at the appropriate temperature, the hydrometer shall indicate the density of the liquid at that temperature.

5 Surface tension

The adjustment in manufacture shall be related to specific capillary conditions as follows.

5.1 When the hydrometer is slightly displaced from its equilibrium position in a liquid, the stem passes through the liquid surface without causing any apparent alteration in the shape of the meniscus.

5.2 The hydrometer scale shall be adjusted either for a given liquid having a given surface tension or for one of the standard categories of surface tension given in Appendix A. Except where the highest precision is required, one of the standard categories of surface tension given in Appendix A shall be used.

For hydrometers of the highest precision, intended for use in particular liquids (e.g. alcohol solutions), the surface tension values appropriate to clean surfaces of these liquids and to the actual indications of the hydrometer shall be used: [see **14.2 c**].

5.3 The sub-series L50SP, M50SP and S50SP are limited to the low surface tension category.

6 Reference levels for adjustment and reading

6.1 The scales of the hydrometers shall be adjusted for readings taken at the level of the horizontal liquid surface.

NOTE If a hydrometer having a scale so adjusted is used in an opaque liquid, readings may be taken at the top of the meniscus where it appears to meet the stem, but an appropriate correction to the level of the horizontal liquid surface should then be made. (See Appendix B.)

6.2 The middle of the thickness of a scale line shall be taken as its definitive position.

7 Immersion

Hydrometers shall be graduated for use with the emergent stem dry, except in the immediate vicinity of the meniscus.

8 Materials and workmanship

8.1 The bulb and the stem shall be made of a suitable transparent glass selected and processed to be as free as possible from stress and visible defects, and having a thermal cubical expansion coefficient of $(25 \pm 2) \times 10^{-6}\text{ }^\circ\text{C}^{-1}$.

NOTE The value of the thermal cubical expansion coefficient conforms with the conventional value quoted in ISO 1768 for use in the preparation of measurement tables for liquids.

8.2 The loading material shall be fixed in the bottom of the hydrometer. After the finished hydrometer has been kept in a horizontal position for 1 h at 80 °C, or any higher temperature at which the hydrometer is intended to be used, and subsequently cooled in that position, the instrument shall meet the requirements of **9.3**.

8.3 There shall be no loose material in the instrument.

8.4 The strip on which the scale and inscriptions are marked shall have a smooth matt surface. The strip shall show no evidence of charring. The strip bearing the scale shall not become discoloured or distorted when the stem is exposed for 1 h to a temperature of 80 °C, or any higher temperature at which the hydrometer is intended to be used.

9 Form

9.1 The outer surface shall be symmetrical about the main axis.

9.2 There shall be no abrupt changes in cross section. The tapered design shown in Figure 1 is preferred, but any design which does not permit air bubbles to be trapped is acceptable.

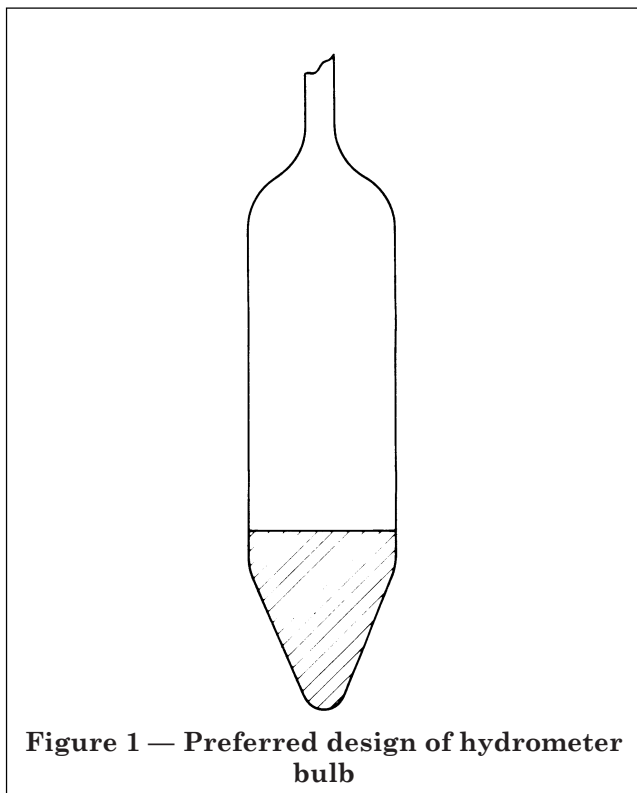


Figure 1 — Preferred design of hydrometer bulb

9.3 The hydrometer shall float with its axis vertical to within 1.5° of arc.

9.4 A thermometer shall not form part of the hydrometer.

10 Scale

Examples of recommended scales for BS hydrometers are illustrated in Figure 2.

10.1 General

10.1.1 The strip on which the scale and inscriptions are marked shall remain securely fastened in place at a temperature of 80 °C or any higher temperature at which the hydrometer is intended to be used.

10.1.2 Appropriate means shall be incorporated for ensuring that any displacement of the strip bearing the scale is readily apparent.

NOTE Any displacement renders the instrument unsuitable for use.

10.1.3 The scale shall be straight and without twist.

10.1.4 No hydrometer shall have more than one type of density scale. If a hydrometer has duplicate scales, the values indicated by them shall not differ.

10.1.5 The scale lines and inscriptions should preferably be black and shall be clearly and durably marked on the strip.

10.2 Graduation lines

10.2.1 The graduation lines shall be distinct and of uniform thickness not exceeding 0.2 mm or $\frac{1}{5}$ of the distance between the centres of adjacent lines, whichever is less. For the SP series, the thickness of the graduation lines shall not exceed 0.2 mm or $\frac{1}{6}$ of the distance between the centres of adjacent lines, whichever is less.

10.2.2 There shall be no evident local irregularities in the spacing of the graduation lines.

10.2.3 The graduation lines shall be perpendicular to the axis of the hydrometer.

10.2.4 Except in the case of duplicate scales, the short, medium and long scale lines shall extend, respectively, at least $\frac{1}{5}$, $\frac{1}{3}$ and $\frac{1}{2}$ of the way round the circumference of the stem.

10.2.5 The highest and lowest graduation lines indicating the nominal limits of the scale shall be long lines (see **10.3.1**, **10.3.2** and **10.3.3**).

10.2.6 The short, medium and long lines shall each be vertically disposed so that either the mid-points or the right hand ends or the left hand ends of all graduation lines shall lie on an imaginary vertical line parallel to the axis of the instrument.

Alternatively in the latter two cases the vertical line may be marked.