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**Hydrometers—Part 1: Density
hydrometers**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry, through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS B 7525-1** : 2013 is replaced with this Standard.

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JIS B 7525 series consists of the following 3 parts under the general title “*Hydrometers*”:

Part 1: Density hydrometers

Part 2: Liquefied petroleum gases density hydrometers

Part 3: Specific gravity meters

Hydrometers—Part 1: Density hydrometers

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 649-1**:1981, Edition 1. Some of the technical contents of the said International Standard have been modified so that they are more in line with the actual usage of density hydrometers in Japan.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JD. Annexes JA to JC are unique to **JIS** and not given in the corresponding International Standard.

Annex JA and Annex JB of this Standard provide, among the requirements for density hydrometers stipulated by the Measurement Act, those related to the technical standards of construction and performance and test methods thereof. Being verified for conformance with these Annexes is not regarded as equivalent to passing the test stipulated by the Measurement Act.

1 Scope

This Standard specifies requirements for five basic series (L20, L50, M50, M100 and S50) of glass density hydrometers of constant mass that are graduated to indicate density (kg/m^3 or g/cm^3) at 20 °C or 15 °C (hereafter referred to as density hydrometers).

Each series comprises density hydrometers which between them cover the interval 600 kg/m^3 to 2 000 kg/m^3 (0.600 g/cm^3 to 2.000 g/cm^3).

The density hydrometers are graduated appropriately for use in liquids of low, medium or high surface tension.

It also specifies three sub-series (L50SP, M50SP and S50SP) of density hydrometers which are graduated to indicate density at either 20 °C or 15 °C. These density hydrometers are limited to the range 600 kg/m^3 to 1 100 kg/m^3 (0.600 g/cm^3 to 1.100 g/cm^3) and are for use in liquids of low surface tension.

The density hydrometers are required to follow the principles of construction and adjustment specified in **ISO 387**. This Standard does not cover density hydrometers with a built-in thermometer.

A table of standard categories of surface tension is given in Annex A. A table of recommended stem diameters is given, for guidance in manufacture, in Annex B.

Examples of form of density hydrometer are shown in Figure 1.

The requirements for density hydrometers used for transactions or certifications are given in Annex JA and Annex JB.

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 649-1:1981 *Laboratory glassware—Density hydrometers for general purposes—Part 1: Specification* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. For standards with the year indication, only the editions of the indicated year shall be applied and the revisions (including amendments) made thereafter shall not be applied. For those without the indication of the year, the most recent edition (including amendments) shall be applied.

JIS B 7616:2013 *Operation and calibration procedures of pressure balances*

JIS Z 8103 *Glossary of terms used in measurement*

ISO 387 *Hydrometers—Principles of construction and adjustment*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS Z 8103**, and the following apply.

3.1

reference temperature

temperature to be used as a reference for graduation of the density scale of the hydrometer

3.2

meniscus top reading

method of taking a reading of a density hydrometer at the top of the meniscus

3.3

horizontal surface reading

method of taking a reading of a density hydrometer at the level of the horizontal surface of the liquid

3.4

scale interval

increment of a quantity of state of physical phenomena corresponding to each spacing between two adjacent graduation lines

4 Basis of scale

The basis of scale shall be density (mass per unit volume) in kilograms per cubic metre (kg/m^3), or in grams per cubic centimetre (g/cm^3) for which the symbol g/ml may be used.

5 Reference temperature

The reference temperature for density hydrometers shall be 20 °C or 15 °C. When used in a liquid at the appropriate temperature, the density hydrometer shall indicate the density of the liquid at that temperature.

6 Maximum permitted error

The maximum permitted errors for the test specified in Clause 15 are shown in Table 1. It is recommended that the density hydrometers in the three sub-series be supplied with certificates of correction, when required for reference purposes.

Table 1 Maximum permitted error

Series	Scale interval	Maximum permitted error
L20	0.000 2 g/cm ³ (0.2 kg/m ³)	$\pm 0.000\ 5\ \text{g/cm}^3$ ($\pm 0.5\ \text{kg/m}^3$)
L50	0.000 5 g/cm ³ (0.5 kg/m ³)	$\pm 0.001\ \text{g/cm}^3$ ($\pm 1.0\ \text{kg/m}^3$)
M50	0.001 g/cm ³ (1 kg/m ³)	$\pm 0.001\ \text{g/cm}^3$ ($\pm 1.0\ \text{kg/m}^3$)
M100	0.002 g/cm ³ (2 kg/m ³)	$\pm 0.002\ \text{g/cm}^3$ ($\pm 2.0\ \text{kg/m}^3$)
S50	0.002 g/cm ³ (2 kg/m ³)	$\pm 0.002\ \text{g/cm}^3$ ($\pm 2.0\ \text{kg/m}^3$)
L50SP	0.000 5 g/cm ³ (0.5 kg/m ³)	$\pm 0.001\ \text{g/cm}^3$ ($\pm 1.0\ \text{kg/m}^3$)
M50SP	0.001 g/cm ³ (1 kg/m ³)	$\pm 0.001\ \text{g/cm}^3$ ($\pm 1.0\ \text{kg/m}^3$)
S50SP	0.001 g/cm ³ (1 kg/m ³)	$\pm 0.001\ \text{g/cm}^3$ ($\pm 1.0\ \text{kg/m}^3$)

7 Surface tension

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

- When the density hydrometer is slightly displaced from its equilibrium position in a liquid, the stem shall pass through the liquid surface without causing any apparent alteration in the shape of the meniscus.
- 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 Annex A. Except where the highest precision is required, one of the standard categories of surface tension given in Annex A shall be used.

For density hydrometers of the highest precision, intended for use in particular liquids (for example alcohol solutions), the surface tension values appropriate to clean surfaces of these liquids and to the actual indications of the density hydrometer shall be used [see 17 c)].

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

8 Reference levels for adjustment and reading

The reference levels for adjustment and reading shall be as follows.

- The scale of the density hydrometer shall be adjusted for readings taken at the level of the horizontal liquid surface or at the top of the meniscus, and which of the reference level is to be used shall be marked on the density hydrometer.

- b) The middle of the thickness of a graduation line shall be taken as its definitive position.

9 Immersion

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

10 Materials and workmanship

The materials and workmanship shall be as follows. If a density hydrometer is intended to be used at a temperature 70°C or higher, the loading material and the scale strip shall meet the requirements of **b)** and **c)** at a temperature slightly above the temperature of use.

- a) 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 coefficient of cubical thermal expansion of $(25 \pm 5) \times 10^{-6}^{\circ}\text{C}^{-1}$.
- b) The loading material shall be fixed in the bottom of the density hydrometer. After the finished density hydrometer has been kept by laying on its side at 70°C for 1 h and subsequently cooled in that position, the instrument shall meet the requirements of **11 c)**.
- c) The scale strip shall be as follows.
 - 1) The scale strip on which the scale and inscriptions are marked shall have a smooth matt surface. The strip shall show no evidence of charring.
 - 2) The scale strip shall not become discoloured or distorted when the stem is exposed to a temperature of 70°C for 1 h.
- d) There shall be no loose material in the instrument.

11 Form

The form shall be as follows.

- a) The outer surface shall be symmetrical about the main axis.
- b) 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.
- c) The density hydrometer shall float with its axis vertical to within 3° of arc.
- d) A thermometer shall not form part of a density hydrometer conforming with this Standard.

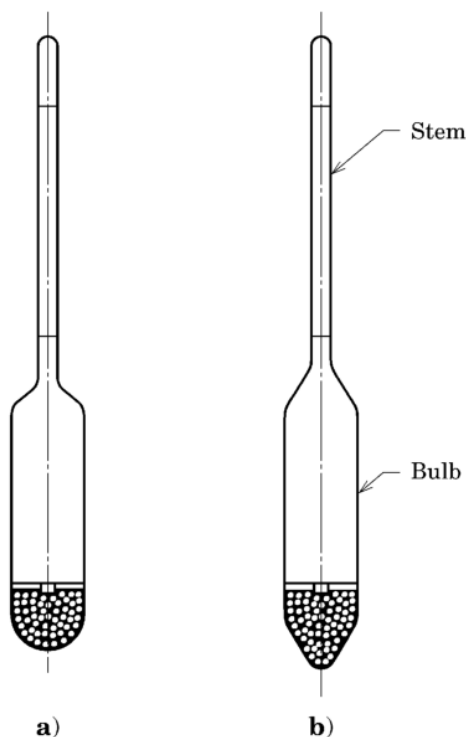


Figure 1 Examples of form of density hydrometer

12 Scale

12.1 General

The scale shall be as follows. Typical scales for the density hydrometers are illustrated in Figure 2.

- The scale strip on which the scale and inscriptions are marked shall remain securely fastened in place at the temperature of use [see 10 c)]. The scale strip may be a white-painted metallic foil.
- The scale strip shall not be displaced. Appropriate means shall be incorporated for ensuring that any displacement of the scale or of the scale strip is readily apparent.
- If a hydrometer has duplicate scales, the values indicated by them shall not significantly differ, and both scales shall comply with the requirements of Clause 6.
- The graduation lines and inscriptions should preferably be black and shall be clearly and durably marked.
- The scale shall be straight and without twist.

12.2 Graduation lines

The graduation lines shall be as follows.

- The graduation lines shall be distinct and of uniform thickness not exceeding 0.3 mm.

- b) For the three sub-series, the thickness of the graduation lines shall not exceed 0.2 mm.
- c) There shall be no evident local irregularities in the spacing of the graduation lines.
- d) The graduation lines shall be straight and without twist.
- e) The graduation lines shall extend at least one-fifth of the way round the circumference of the stem.
- f) The highest and lowest graduation lines indicating the nominal limits of the scale shall be long lines (see **12.3**).
- g) 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 line parallel to the axis of the instrument.

12.3 Sequence of graduation lines

The sequence of graduation lines shall be as follows.

- a) On hydrometer scales whose scale interval is 1 kg/m^3 or 0.001 g/cm^3 :
 - 1) every tenth graduation line shall be a long line;
 - 2) there shall be a medium line between two consecutive long lines;
 - 3) there shall be four short lines between consecutive medium and long lines.
- b) On hydrometer scales whose scale interval is 2 kg/m^3 , 0.2 kg/m^3 , 0.002 g/cm^3 or $0.000 2 \text{ g/cm}^3$:
 - 1) every fifth graduation line shall be a long line;
 - 2) there shall be four short lines between two consecutive long lines.
- c) On hydrometer scales whose scale interval is 0.5 kg/m^3 or $0.000 5 \text{ g/cm}^3$:
 - 1) every tenth graduation line shall be a long line;
 - 2) there shall be four medium lines between two consecutive long lines.
 - 3) there shall be one short line between two consecutive medium lines and between consecutive medium and long lines.

12.4 Figuring of graduation lines

The figuring of graduation lines shall be as follows.

- a) Except in the case of duplicate scales, the scale shall have only one set of numbers, and the scale numbers may be aligned either vertically or horizontally.
- b) The scale shall be figured so as to enable the value corresponding to any graduation line to be readily identified.
- c) The highest and lowest graduation lines of the nominal limits shall be figured in full.
- d) At least every tenth line shall be figured.

- e) Density values shall be indicated with numbers expressed in full. However, abbreviated numbers with some digits omitted may be used.

12.5 Extension of scale

The scale shall be extended beyond the nominal scale limits as indicated in Table 2.

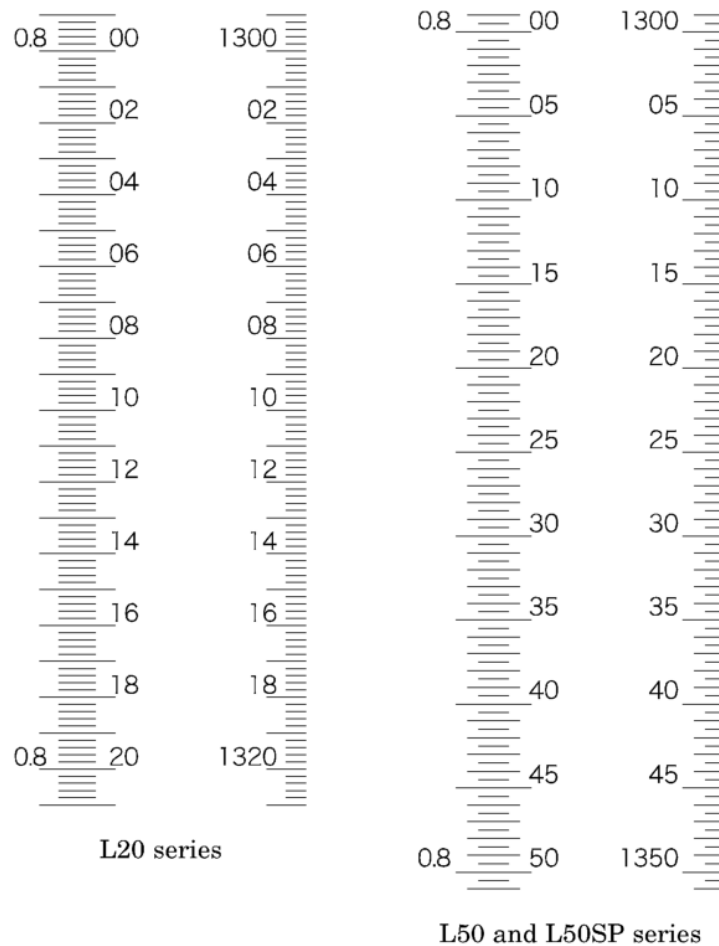


Figure 2 Typical scales