INTERNATIONAL STANDARD

ISO 15212-2

First edition
2002-03-01

Oscillation-type density meters —

Part 2: Process instruments for homogeneous liquids

Densimètres à oscillation —

Partie 2: Instruments industriels pour liquides homogènes

Reference number
ISO 15212-2:2002(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 15212 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15212-2 was prepared by Technical Committee ISO/TC 48, *Laboratory glassware and related apparatus*, Subcommittee SC 4, *Density measuring instruments*.

ISO 15212 consists of the following parts, under the general title *Oscillation-type density meters*:

— *Part 1: Laboratory instruments*

— *Part 2: Process instruments for homogeneous liquids*

Introduction

Density values of pure water at different temperatures and information on how to calculate the density values at different pressures can be found in ISO 15212-1:1998, annex A.

Oscillation-type density meters —

Part 2:
Process instruments for homogeneous liquids

1 Scope

This part of ISO 15212 specifies metrological requirements, among others, for oscillation-type density meters as well as for functional units (see 4.2) of oscillation-type density meters, which are used in process for all kinds of homogeneous liquids. This includes liquified gases. Instructions and methods for installation, preadjustment, adjustment and calibration of process instruments are also given. The instruments are either integral systems or functional units, which can be combined into an integral measuring system.

This part of ISO 15212 does not describe the method of use of process density meters for particular applications or products, e.g. petroleum products or beverages. Such methods of use can be defined by relevant institutions such as ISO or responsible Government agencies.

This part of ISO 15212 does not define an instrument specification for any particular application. For this information reference should be made to the relevant standard covering the method of use.

This part of ISO 15212 is addressed to manufacturers of density meters and to bodies, testing and certifying the conformity of density meters. This part of ISO 15212 also gives recommendations for adjustment and calibration of process density meters.

Oscillation-type density meters used in laboratories are addressed in ISO 15212-1.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 15212. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 15212 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 15212-1:1998, *Oscillation-type density meters — Part 1: Laboratory instruments*

IEC 61010-1, *Safety requirements for electrical equipment for measurement, control and laboratory use — Part 1: General requirements*

IEC 61326-1, *Electrical equipment for measurement, control and laboratory use — EMC requirements*

Guide to the Expression of Uncertainty in Measurement (GUM). BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML

3 Terms and definitions

For the purposes of this part of ISO 15212, the terms and definitions given in ISO 15212-1 and the following apply.

3.1
preadjustment
⟨process density meter⟩ adjustment performed in a laboratory environment before installation

NOTE Adjustment, see 3.1 of ISO 15212-1:1998.

3.2
laboratory calibration
⟨process density meter⟩ calibration for the intended entire working range of the instrument performed in a laboratory environment before installation

NOTE Calibration, see 3.2 of ISO 15212-1:1998.

3.3
***in-situ* calibration**
⟨process density meter⟩ calibration of the installed instrument for its actual working conditions in a process environment

4 Principle and functional units

4.1 Measuring principle

The sensors used in density meters are electrically or mechanically induced oscillating systems, whose oscillation frequencies or periods are a function of the liquid density. Depending on the sensor design, the liquid can either flow through the sensor or the sensor can be immersed in the liquid. Instrument constants of the adjusted density meter are used to calculate the sample density from the oscillation frequency or oscillation period and from associated measurements, e.g. temperature or pressure.

4.2 Functional units

Oscillation-type process density meters shall consist of the following functional units:

a) a density sensor through which the liquid flows or which is immersed in the liquid;

b) a device to determine the density sensor temperature;

c) a device to condition and/or preamplify the density sensor signal;

d) a device to condition and/or preamplify the temperature sensor signal;

e) a unit for signal processing, output of results and functional monitoring.

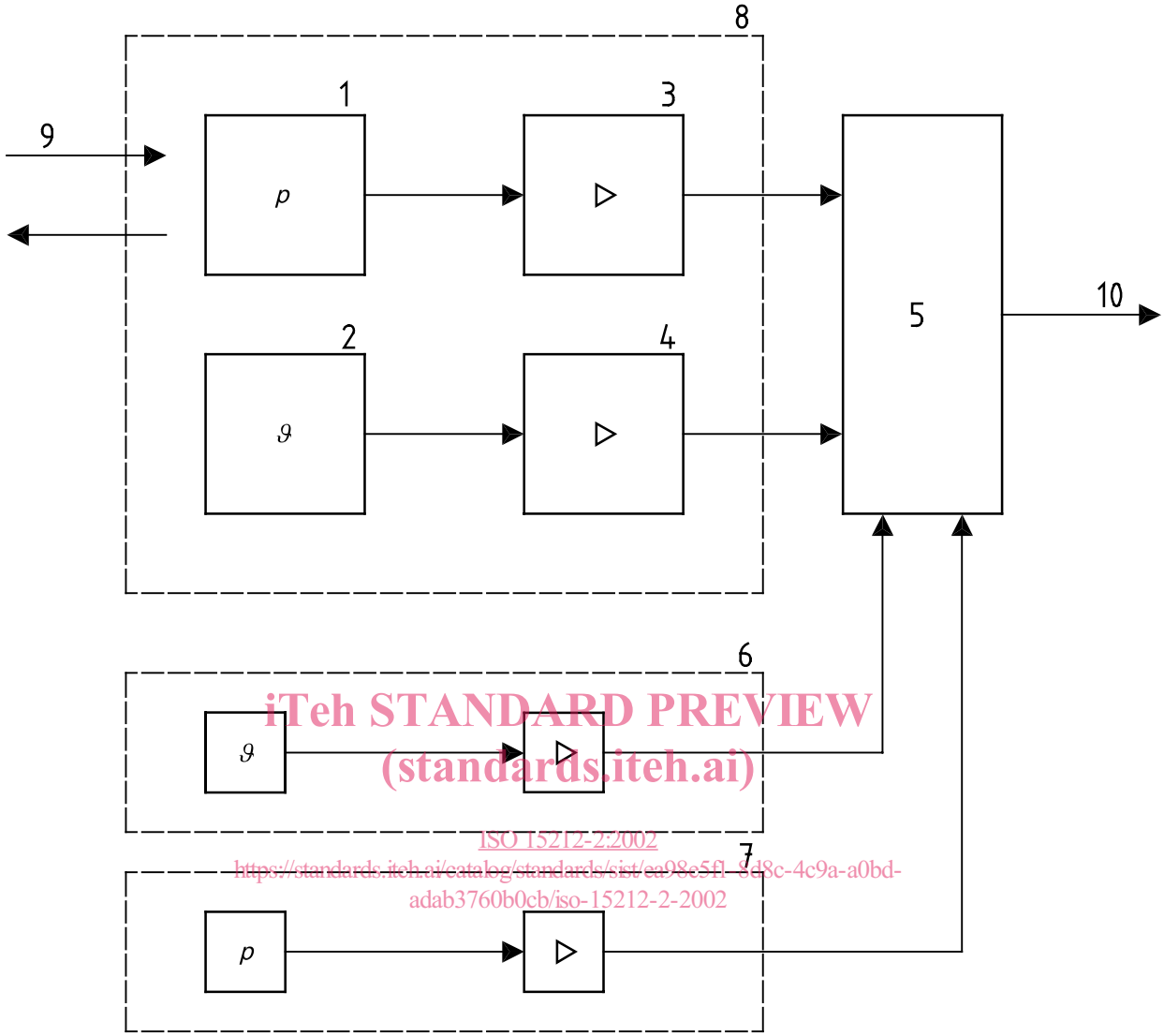
Optional functional units of process density meters may be:

f) a temperature transducer to measure the liquid temperature (see item 6 in Figure 1);

g) a pressure transducer to measure the liquid pressure (see item 7 in Figure 1).

The functional units a) to d) are often referred to as density measuring transducer (see item 8 in Figure 1). The unit e) can be referred to as processing or indicating unit (see item 5 in Figure 1) and may accept additional signals or process parameters, e.g. from a flow meter.

The functional units, items 5 and 8 in Figure 1, can be integrated into a single instrument or can be separate units.



Key

1 Density sensor [see 4.2 a)]
2 Temperature sensor [see 4.2 b)]
3 Density sensor signal preamplification [see 4.2 c)]
4 Temperature sensor signal preamplification [see 4.2 d)]
5 Processing or indicating unit [see 4.2 e)]
6 Temperature transducer [see 4.2 f)]
7 Pressure transducer [see 4.2 g)]
8 Density measuring transducer
9 Liquid to be measured
10 Output (display, printer, interface)

Figure 1 — Functional units of a process density meter

5 Density sensor

5.1 Sensor material

Density sensor materials can be, for example, metal, metal alloys, coated metals or glass. The material is considered to be suitable if it is compatible with the process liquids to be measured at the process conditions and with the cleaning agents to be used in the density meter. Erosion, abrasion as well as special forms of corrosion shall be considered in this respect since they have an impact on the accuracy of the instrument. The manufacturer shall provide certificates about the sensor material on request.

5.2 Sensor design

Density sensors can be designed as straight, U-formed or omega-formed tubes. Other designs are tuning-forks, cylinders, bells or membranes. All designs which conform with the functional principle in accordance with 4.1 can be constructed.

6 Requirements and tests

6.1 General

All the tests of this clause are intended to be type tests.

6.2 Density measuring transducer

6.2.1 Drift

6.2.1.1 Within 30 days, the drift of the measured density $\Delta\rho_{30}$ at a temperature of 20 °C, at a pressure of 0,1 MPa to 0,2 MPa[1)] (1 bar to 2 bar) and at a typical flow rate specified in the manual shall not exceed 20 % of the maximum permissible error specified by the manufacturer for the instrument.

If the working range of the density meter does not include the above mentioned conditions, the drift at the typical measuring conditions of the density meter shall not exceed 40 % of the specified maximum permissible error.

6.2.1.2 The test for the drift determination shall be performed as follows:

— install the instrument, preadjusted by the manufacturer, to a liquid circulation system; suited liquids can be for example water or mineral oil;

— switch on the instrument and attemper it for 24 h;

— circulate the liquid through the instrument and record the density at least three times at $(20 \pm 0{,}1)$ °C within 30 min;

— record the mean value ρ_1 of the density measurement;

— repeat the density measurement (without a new adjustment) and mean value calculation ρ_2 after a minimum of 30 days.

1) 1 bar $= 10^5$ N/m^2 $=$ 0,1 MPa.

Instrument, liquid circulation and thermostating device shall be in operation during the whole test.

During the minimum time period of 30 days between the two density measurements, the instrument shall be run at least 2 days at a temperature of (10 ± 1) °C and another 2 days at a temperature of (30 ± 1) °C.

To calculate the drift, $\Delta\rho_{30}$, use the following equation:

$$\Delta\rho_{30} = \frac{\rho_1 - \rho_2}{\Delta t} \tag{1}$$

where Δt is the difference in days between the two threefold measurements.

If the density measuring transducer is not designed for a measuring temperature of 20 °C, testing shall be performed at the mean measuring temperature of the density measuring transducer. The increased and decreased temperature between the two density measurements shall be +10 °C and −10 °C from this mean measuring temperature.

6.2.2 Effect of liquid properties

6.2.2.1 The density measuring transducer shall be constructed in such a way, that the maximum permissible errors are in accordance with the requirements given in 9.1 when measuring liquids with different sound velocities and, where appropriate, having different viscosities.

6.2.2.2 For testing, use Newtonian liquids with known densities and sound velocities as well as, where appropriate, known viscosities. They shall cover the intended application range of the density meter specified by the manufacturer with regard to sound velocity and viscosity. Testing shall be performed in accordance with 9.2.

6.2.3 Deviation between liquid and sensor temperatures

6.2.3.1 The density measuring transducer shall be designed to minimize the deviation between liquid temperature and sensor temperature. The density deviations due to this temperature deviation at constant flow and temperature shall not exceed 50 % of the specified maximum permissible error of the density measuring transducer.

6.2.3.2 Testing shall be performed by comparing the densities determined by the density measuring transducer with the actual densities of a suitable test liquid of known density at three different temperatures, being approximately the lower, upper and mean value of the specified liquid temperature range. Ambient temperature shall be kept constant to within ± 1 °C of the mean value for the specified ambient temperature range of the density measuring transducer. For this test

— switch on the density measuring transducer and circulate the test liquid for at least 1 h at a temperature as specified above and at a suitable flow rate;

— determine the actual liquid temperature as mean value of the temperatures at the inlet and outlet of the density transducer, measured by suitable thermometers;

— calculate the deviation between the actual density of the test liquid of known density at the actual liquid temperature and the density displayed by the density measuring transducer;

— repeat the test at the two other temperatures specified above.

Ethanol, *n*-nonane or mineral oil are suitable test liquids for this test.

6.2.4 Effect of instrument parts oscillations

6.2.4.1 Measurement deviations arising from parasitic resonances of instrument parts on the density measuring transducer shall not exceed 35 % of the maximum permissible error over the whole measuring range, specified for the density measuring transducer by the manufacturer.

6.2.4.2 For testing, examine the oscillatory characteristics of the built-in density sensor provided by the manufacturer. This test may not show any parasitic resonant points (see 3.3 of ISO 15212-1:1998) whose effects