

Adopted:  
2 October 2012

## **OECD GUIDELINE FOR THE TESTING OF CHEMICALS**

### **Density of Liquids and Solids**

#### **INTRODUCTION**

1. This Test Guideline is a revision of the Test Guideline 109 originally adopted in 1981 and first revised in 1995. This revision adds CIPAC MT 186 (1) published in 2003, which supersedes MT 159 cited by OPPTS 830.7300 (2) as an option for density determination: the major revision in 2012 is inclusion of *pour and tap (solid)*.

#### **INITIAL CONSIDERATIONS**

2. Most methods for determining the density of liquids and solids are the object of national and international standardizing bodies and are frequently specified by governmental agencies. This Guideline lists these methods, giving only a very succinct description of them, and the reader is referred to the standards which are listed in the appendix. Some other methods mentioned in the Guideline are taken from the scientific literature, and again only succinct information is given on the methods.

3. An aerosol product is a pressurized liquid. The density measurement of an aerosol product is performed on the liquid remaining after the aerosol product has been depressurized.

#### **SIGNIFICANCE**

4. This Test Guideline provides procedures to obtain density of chemicals (substances and mixtures). The data may be used to assess the manner and extent that chemicals and components of mixtures will be transported in the environment and locations where they may be deposited.

#### **DEFINITION AND UNITS**

5. The density,  $\rho$  is the quotient of mass,  $m$ , and volume,  $V$ , and is expressed in SI units as  $\text{kg/m}^3$  at a specified temperature. The relative density ( $D_{20/4}$ , density at 20 degrees Centigrade relative to water at 4 degrees Centigrade) may be used to compare different chemicals.

#### **REFERENCE SUBSTANCES**

6. Reference substances, or liquids of known density, need to be employed when determining the density of a chemical by oscillating densitometry.

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**PRINCIPLE OF THE METHODS*****Hydrometer (a buoyancy method for liquids)***

7. Hydrometers are weighted glass floats which sink into the liquid to a depth dependent on the density. The density is read at the level of the liquid on a calibrated stem extending above the liquid. The dynamic viscosity of the liquid to be investigated should not exceed 5 Pa.s.

***Hydrostatic balance (a buoyancy method for liquids and solids)***

8. The density of a solid is derived from the difference in weight between a sample in air and in a liquid of known density (e.g. water). The density thus measured is only representative of the particular sample employed (bulk density).

9. For the determination of density of liquids, a solid body of known volume is weighed first in air and then when immersed in the liquid. The dynamic viscosity of liquids to be investigated should not exceed 5 Pa.s.

***Immersed body method (a buoyancy method for liquids)***

10. A vessel containing a sample of the liquid test substance is placed on a balance and weighed. Then, a body of known volume (generally a sphere of approximately 10 cm<sup>3</sup> made of metal), which is clamped to a stand independent from the balance, is immersed in the liquid. The action exerted by the immersed body on the balance cannot be distinguished from that of a freely floating body with a volume identical with that of the immersed body and having the density of the surrounding liquid. The density of the liquid is obtained by dividing the gain in weight due to the immersion of the body by the known volume of the body. The method is applicable to liquids with a dynamic viscosity below 20 Pa.s (3).

***Pycnometer (liquids and solids)***

11. The density is calculated from the difference in weight between the full and empty pycnometer and its volume. In the case of liquids, the dynamic viscosity should not be above 500 Pa.s.

***Air comparison pycnometer (solids)***

12. The volume of a sample of the solid is measured in air or in an inert gas in a calibrated cylinder of variable volume. After concluding the volume measurement, the sample is weighed.

***Oscillating densitometer (liquids)***

13. A mechanical oscillator, constructed in the form of a U-tube, is vibrated at its resonance frequency which depends on its mass. Introducing a sample changes the resonance frequency. The apparatus should be calibrated with two liquids of known density. The liquids should preferably be chosen such that their densities span the range into which the liquid under investigation falls. The method is applicable to liquids with a dynamic viscosity below 5 Pa.s.

***Pour and tap (solids)***

14. A known weight of a solid material is placed in a glass graduated (i.e. measuring) cylinder and its volume measured to determine the 'pour density.' The cylinder is then raised and allowed to fall vertically through a distance of 25 mm on a rubber pad 50 times (or this may be performed using a Dry Substance

Jolting Volumeter as described in ISO 787/11). The volume is measured again to determine the 'tap density.'

#### **TEST CONDITIONS**

15. The test is done at constant temperature, preferably at 20°C. Duplicate measurements are required.

#### **DESCRIPTION OF THE METHODS**

16. For the technical details of apparatus and procedures, the standards listed in the appendix should be consulted.

#### **TEST REPORT**

17. The test report includes the following information;

- method used;
- chemical identity and impurities (preliminary purification step, if any);
- estimated accuracy;
- results obtained with the reference substances when used for calibration or comparison;
- density (the mean of at least two measurements which are in the range of the estimated accuracy);
- the dynamic viscosity of liquids to confirm that the method chosen was appropriate for the substance;
- all information and remarks relevant for the interpretation of the results, especially with regards to impurities and physical state of the substance.

## LITERATURE

1. Collaborative International Pesticide Analytical Council, Ltd. (CIPAC) (2003), *Handbook K, "MT 186 Bulk Density"* CIPAC, ( 2003). [www.cipac.org](http://www.cipac.org) , Publications available from: Marston Book Services Ltd.: (<http://www.marston.co.uk>)
2. United States Environmental Protection Agency (EPA) (2002), *Product Properties Test Guidelines OPPTS 830.7300 "Density / Relative Density / Bulk Density,"* EPA 712-C-02-035.
3. Wagenbreth, H. (1979), Die Tauchkugel zur Bestimmung der Dichte von Flüssigkeiten, *Technisches Messen*, vol. 11, 427-430.

## LIST OF STANDARDS

**Hydrometer**

|                |  |
|----------------|--|
| ASTM D 1298    | Density, specific gravity or API gravity of crude petroleum and liquid petroleum products by hydrometer method |
| BS EN ISO 3675 | Crude petroleum and liquid petroleum products. Laboratory determination of density. Hydrometer method          |
| DIN 12791-1    | Laboratory glassware - density hydrometers - Part 1: general requirements                                      |
| DIN 12791-2    | Laboratory glassware - density hydrometers, standard sizes, designators  |
| ISO 387        | Hydrometers - Principles of construction and adjustment  |
| ISO 649-1      | Density hydrometers for general purposes - Specification   |
| ISO 649-2      | Density hydrometers for general purposes - Test methods and use  |

**Hydrostatic balance***for solid substances*

|             |  |
|-------------|--|
| NF T 20-049 | Chemical products for industrial use - Determination of the density of solids other than powders and cellular products |
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*for liquid substances*

|             |   |
|-------------|---|
| ASTM D 1481 | Test Method for Density and Relative Density (Specific Gravity) of Viscous Materials by Lipkin Bicapillary Pycnometer |
| DIN 51757   | Testing of mineral oils and related materials - determination of density  |
| ISO 758     | Liquid chemical products, determination of density at 20°C  |

**Immersed body method**

|                  |   |
|------------------|---|
| BS EN ISO 2811-2 | Paints and varnishes - determination of density, Part 2: immersed body (plummet) method |
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**Pycnometer**

|             |  |
|-------------|--|
| ISO 3507    | Pyknometers  |
| NF T 20-053 | Chemical products for industrial use- Determination of density of solids in powder and liquids |

*for liquid substances*

|                  |   |
|------------------|---|
| BS 4699          | Method for determination of specific gravity and density of petroleum products (graduated bicapillary pycnometer method)  |
| BS EN ISO 3838   | Methods of test for petroleum and its products - BS 2000-189/190: crude petroleum and liquid or solid petroleum products - determination of density or relative density - capillary-stoppered pyknometer and graduated bicapillary pyknometer methods |
| DIN ISO 3507     | Laboratory glassware pyknometers  |
| BS EN ISO 2811-1 | Paints and varnishes - determination of density, Part 1: pyknometer method  |
| ISO 758          | Liquid chemical products for industrial use - Determination of density at 20°C  |

*for solid substances*

|         |   |
|---------|---|
| ISO 901 | Aluminum oxide primarily used for the production aluminum-<br>Determination of absolute density |
|---------|---|

**Pour and tap**

|        |  |
|--------|--|
| MT 186 | Collaborative International Pesticide Analytical Council, Ltd. (CIPAC) Handbook K "MT 186 Bulk Density" CIPAC, CIPAC (2003). <a href="http://www.cipac.org">www.cipac.org</a> , Publications available from: Marston Book Services Ltd.: ( <a href="http://www.marston.co.uk">http://www.marston.co.uk</a> ) |
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