

Measurement of liquid flow in closed conduits —

**Method by collection of the liquid in a
volumetric tank**

The European Standard EN ISO 8316:1995 has the status of a
British Standard

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the industrial-process Measurement and Control Standards Committee (PCL/-) to Technical Committee PCL/2, upon which the following bodies were represented:

- British Compressed Air Society
- British Gas plc.
- Department of Energy (Gas and Oil Measurement Branch)
- Department of Trade and Industry (National Engineering Laboratory)
- Department of Trade and Industry (National Weights and Measures Laboratory)
- Electricity Supply Industry in England and Wales
- Energy Industries Council
- GAMBICA (BEAMA Ltd.)
- Institute of Measurement and Control
- Institute of Trading Standards Administration
- Institution of Gas Engineers
- Institution of Mechanical Engineers
- Water Authorities Association

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- Society of British Gas Industries
- University of Surrey

This British Standard, having been prepared under the direction of the Industrial-process Measurement and Control Standards Committee, was published under the authority of the Board of BSI and comes into effect on 30 September 1988

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National foreword

This British Standard has been prepared by Technical Committee CPL/30 (formerly PCL/2). It is identical with ISO 8316:1987 “*Measurement of liquid flow in closed conduits — Method by collection of the liquid in a volumetric tank*”, published by the International Organization for Standardization (ISO).

In 1995 the European Committee for Standardization (CEN) accepted ISO 8316:1987 as European Standard EN ISO 8316:1995. As a consequence of implementing the European Standard this British Standard is renumbered as BS EN ISO 8316 and any reference to BS 6199-2:1988 should be read as a reference to BS EN ISO 8316.

Terminology and conventions. The text of the international standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

Wherever the words “International Standard” appear, referring to this standard, they should be read as “Part of BS 6199”.

The comma has been used as a decimal marker. In British Standards it is current practice to use a full point on the baseline as a decimal marker.

Cross-references

International standard	Corresponding British Standard
ISO 4006:1977	BS 5875:1980 <i>Glossary of terms and symbols for measurement of fluid flow in closed conduits</i> (Identical)
ISO 5168:1978	BS 5844:1980 <i>Methods of measurement of fluid flow: estimation of uncertainty of a flow-rate measurement</i> (Identical)

At present there is no corresponding British Standard for ISO 4373. The Technical Committee has reviewed the provisions of ISO 4373 and has decided that they are acceptable for use in conjunction with this standard.

ISO 4185, although listed in clause 2, is not referred to in the text.

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 and ii, the EN ISO title page, pages 2 to 26, 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.

ICS 17.120.10

Descriptors: Liquid flow, pipe flow, flow measurements, volume measurements, tanks containers, gauging, flow rate, flowmeters, error analysis

English version

Measurement of liquid flow in closed conduits — Method by collection of the liquid in a volumetric tank

(ISO 8316:1987)

Mesure de débit des liquides dans les conduites fermées — Méthode par jaugeage d'un réservoir volumétrique
(ISO 8316:1987)

Durchflußmessung von Flüssigkeiten in geschlossenen Leitungen — Verfahren der Volumenbestimmung mit einem Meßbehälter
(ISO 8316:1987)

This European Standard was approved by CEN on 1995-08-31. CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
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Foreword

This European Standard was taken over by CEN from the work of ISO/TC 30, *Measurement of fluid flow in closed conduits*, of the International Standards Organization (ISO).

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 1996, and conflicting national standards shall be withdrawn at the latest by March 1996.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

1 Scope and field of application

This International Standard specifies methods for the measurement of liquid flow in closed conduits by determining the volume of liquid collected in a volumetric tank in a known time interval. It deals in particular with the measuring apparatus, the procedure, the method for calculating the flow-rate and the assessment of uncertainties associated with the measurements.

The method described may be applied to any liquid provided that

- a) its vapour pressure is sufficiently low to ensure that any escape of liquid by vaporization from the volumetric tank does not affect the required measurement accuracy;
- b) its viscosity is sufficiently low so as not to alter or delay unduly the measurement of the level in the volumetric tank;
- c) it is non-toxic and non-corrosive.

Theoretically, there is no limit to the application of this method, but, for practical reasons, this method of measurement is normally used for flow-rates less than approximately $1,5 \text{ m}^3/\text{s}$ and is used on the whole in fixed laboratory installations only. However, there is a variation of this method which uses a natural or artificial storage pond as a volumetric tank, but this application is not dealt with in this International Standard.

Owing to its high potential accuracy, this method is often used as a primary method for calibrating other methods or devices for volume flow-rate measurement or for mass flow-rate measurement; for the latter method or device, it is necessary to know the density of the liquid accurately.

If the installation for flow-rate measurement by the volumetric method is used for purposes of legal metrology, it shall be certified and registered by the national metrology service. Such installations are then subject to periodic inspection at stated intervals. If a national metrology service does not exist, a certified record of the basic measurement standards (length, time and temperature), and error analysis in accordance with this International Standard and ISO 5168, shall also constitute certification for legal metrology purposes.

Annex A forms an integral part of this International Standard. Annex B to Annex E, however, are given for information only.

2 References

ISO 4006, *Measurement of fluid flow in closed conduits — Vocabulary and symbols*.

ISO 4185, *Measurement of liquid flow in closed conduits — Weighing method*.

ISO 4373, *Measurement of liquid flow in open channels — Water level measuring devices*.

ISO 5168, *Measurement of fluid flow — Estimation of uncertainty of a flow-rate measurement*.

3 Symbols and definitions

3.1 Symbols (see also ISO 4006)

Table 1

Symbol	Quantity	Dimensions	SI unit
e_R	Random uncertainty, in absolute terms	^a	^a
E_R	Random uncertainty, as a percentage	—	—
e_S	Systematic uncertainty, in absolute terms	^a	^a
E_S	Systematic uncertainty, as a percentage	—	—
q_m	Mass flow-rate	MT^{-1}	kg/s
q_V	Volume flow-rate	L^3T^{-1}	m^3/s
t	Filling time of the tank	T	s
V	Discharged or measured volume	L^3	m^3
z	Liquid level in the tank	L	m
ρ	Density	M^{-3}	kg/m^3

^a The dimensions and units are those of the quantities in question.

3.2 Definitions

For the purposes of this International Standard, the definitions given in ISO 4006 apply. Only terms which are used with a particular meaning or the meaning of which might be usefully restated are defined below. The definitions of some of the terms concerned with error analysis are given in ISO 5168.

3.2.1

static gauging

a method by which the net volume of liquid collected is deduced from measurements of liquid levels (i.e. gaugings), made respectively before and after the liquid has been diverted for a measured time interval into the gauging tank, to determine the volume contained in the tank

3.2.2

dynamic gauging

a method by which the net volume of liquid collected is deduced from gaugings made while liquid flow is being delivered into the gauging tank. (A diverter is not required with this method.)

3.2.3

diverter

a device which diverts the flow either to the gauging tank or to its by-pass without changing the flow-rate during the measurement interval

3.2.4

flow stabilizer

a device inserted into the measuring system, ensuring a stable flow-rate in the conduit being supplied with liquid; for example, a constant level head tank, the level of liquid in which is controlled by a weir of adequate length

4 Principle

4.1 Statement of the principle

4.1.1 *Static gauging method*

The principle of the flow-rate measurement method by volumetric static gauging (see Figure 1 for a schematic diagram of a typical installation) is

- to determine the initial volume of liquid contained in the tank;
- to divert the flow into the volumetric tank, until it is considered to contain a sufficient quantity to attain the desired accuracy, by operation of a diverter which actuates a timer to measure the filling time;
- to determine the final volume of liquid contained in the tank. The volume contained at the initial and at the final times is obtained by reading the liquid levels in the tank and by reference to a preliminary calibration which gives the level-volume relationship.

The flow-rate is then derived from the volume of liquid collected and the filling time as explained in clause 7.

One variation of this method uses two tanks which are successively filled (see 6.3). A further variation, given in Annex D, uses a valve instead of a diverter mechanism to start and stop the flow into a volumetric tank.

Care shall be taken when using a valve instead of a diverter that the flow-rate does not change when the valve is operated.

4.1.2 *Dynamic gauging method*

The principle of the flow-rate measurement method by volumetric dynamic gauging (see Figure 2 for a schematic diagram of a typical installation) is

- to let liquid collect in the tank to a predetermined initial level (and thus volume), at which time the timer is started;
- to stop the timer when a second predetermined final level (and thus volume) is reached and then to drain the liquid collected.

The flow-rate is then derived as explained in clause 7.

4.1.3 *Comparison of instantaneous and mean flow-rates*

It should be emphasized that only the mean value of flow-rate for the filling period is given by the volumetric method. Instantaneous values of flow-rate as obtained on another instrument or meter in the flow circuit may be compared with the mean flow-rate only if the flow is kept stable during the measurement interval, by a flow-stabilizing device, or if the instantaneous values are properly time-averaged during the whole filling period.

4.2 *Accuracy of the method*

4.2.1 *Overall uncertainty in the volumetric measurement*

The volumetric method gives a measurement of flow-rate which, in principle, requires only level and time measurements. After the weighing method, the static gauging method in a volumetric tank may be considered as one of the most accurate of all flow-rate measuring methods, particularly if the precautions given in 4.2.2 are taken. For this reason, it is often used as a standard or calibration method. When the installation is carefully constructed, maintained and used, an uncertainty of $\pm 0,1\%$ to $\pm 0,2\%$ (with 95 % confidence limits) may be achieved.

4.2.2 *Requirements for accurate measurements*

The volumetric method gives an accurate measurement of flow-rate provided that

- a) there is no leak in the flow circuit and there is no unmeasured leakage flow across the diverter;
- b) the conduit is running full at the measuring section and there is no vapour or air-lock between the measuring section and the volumetric tank;
- c) there is no accumulation (or depletion) of liquid in a part of the circuit by thermal contraction (or expansion) and there is no accumulation (or depletion) by change in vapour or gas volume contained unknowingly in the flow circuit;
- d) care has been taken to avoid any leakage from or unwanted flow into the tank, absorption of liquid by the walls or their coatings, deformation of the walls etc.;
- e) the level-volume relationship in the tank has been established by transferring known volumes, or by calculation from dimensional measurements of the tank, as specified in 5.5;
- f) the level measuring devices and the means for starting and stopping the timer achieve the required accuracies;
- g) the time required by the diverter (for the static gauging method) for traversing is short with respect to the filling time, the timer being started and stopped while the diverter is crossing the hydraulic centreline (this position shall be checked and adjusted, if necessary, using the methods described in Annex A);
- h) the temperature of the liquid flowing through the flowmeter under test is either the same as that collected in the volumetric tank or it is corrected accordingly.

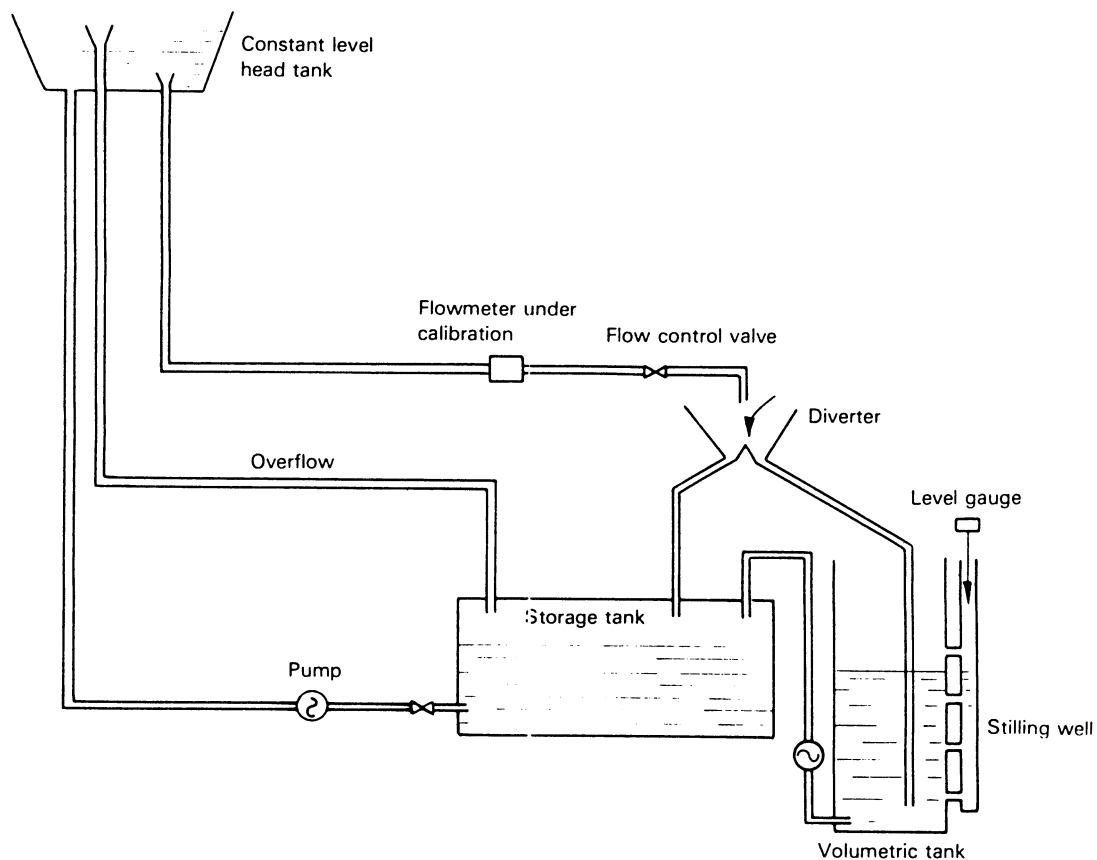


Figure 1 — Schematic diagram of a volumetric flow-rate installation using the static gauging method