BS ISO 7507-2:2022

BSI Standards Publication

Petroleum and liquid petroleum products — Calibration of vertical cylindrical tanks

Part 2: Optical-reference-line method or electro-optical distance-ranging method

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National foreword

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Part 2: Optical-reference-line method or electro-optical distance-ranging method

Pétrole et produits pétroliers liquides — Jaugeage des réservoirs cylindriques verticaux —

Partie 2: Mesurage par ligne de référence optique ou mesurage électro-optique de la distance

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 28, *Petroleum and related products, fuels and lubricants from natural or synthetic sources*, Subcommittee SC 2, *Measurement of petroleum and related products*.

This third edition cancels and replaces the second edition (ISO 7507-2:2005), which has been technically revised.

The main changes are as follows:

— offsets between reference circumference and specified levels are measured by electro-optical distance-ranging method.

A list of all parts in the ISO 7507 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document forms part of a family of documents on tank calibration listed in the Bibliography as References [2] to [6], as well as ISO 7507-1 and ISO 7507-4 which are listed in Clause 2.

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Petroleum and liquid petroleum products — Calibration of vertical cylindrical tanks —

Part 2: Optical-reference-line method or electro-optical distance-ranging method

1 Scope

This document specifies methods for the calibration of tanks above eight metres in diameter with cylindrical courses that are vertical. It provides two methods for determining the volumetric quantity of the liquid contained within a tank at gauged liquid levels.

NOTE For optical-reference-line method, the optical (offset) measurements required to determine the circumferences can be taken internally or externally, provided that insulation is removed if tank is insulated.

The methods are suitable for tilted tanks with up to 3 % deviation from the vertical provided that a correction is applied for the measurement tilt, as described in ISO 7507-1.

These methods are alternatives to other methods such as strapping (ISO 7507-1) and the optical-triangulation method (ISO 7507-3).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4269, *Petroleum and liquid petroleum products — Tank calibration by liquid measurement — Incremental method using volumetric meters*

ISO 7507-1:2003, *Petroleum and liquid petroleum products — Calibration of vertical cylindrical tanks — Part 1: Strapping method*

ISO 7507-4, *Petroleum and liquid petroleum products — Calibration of vertical cylindrical tanks — Part 4: Internal electro-optical distance-ranging method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7507-1, ISO 7507-4 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
optical-reference-line
vertical optical ray (virtual) that is established using the optical device at a given location

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3.2
magnetic trolley
mechanical device that can be traversed up or down the tank shell wall to measure deviations in the tank shell relative to the *optical-reference-line* (3.1) using a horizontal scale that is mounted on the trolley

3.3
station
location where the optical device and the *magnetic trolley* (3.2) are placed for optical measurements

3.4
horizontal station
station where the optical device is located as it is moved around the tank circumference

3.5
vertical station
station where the magnetic trolley is located along the tank shell wall

3.6
reference circumference
circumference measured at the bottom course that forms the basis for subsequent computations

3.7
reference offset
distance of the shell wall (at each horizontal station) from the *optical-reference-line* (3.1) measured at the bottom course where the *reference circumference* (3.6) is measured

4 Precautions

The general precautions and safety precautions specified in ISO 7507-1 shall apply to this document.

5 Equipment

5.1 Equipment for tank strapping

Equipment consists of the following, as specified in ISO 7507-1:

— strapping tapes;

— spring balance;

— step-over;

— littlejohn grip;

— dip-tape and dip-weight.

5.2 Optical-reference-line method

5.2.1 Optical-reference-line device, such as a precision optical plummet, a precision engineer's level with a pentaprism attachment, or a precision engineer's theodolite with a pentaprism attachment.

NOTE 1 These are optical instruments with a means of attachment to either a tripod, magnetic bracket or other stable means of support.

The instrument, when set on its support and levelled, either manually using bubble vials or automatically if an automatic levelling device is fitted, shall be capable of giving a vertical line of sight.

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The instrument should preferably be of short focal length so that, when set up at a practical working height, it can be focused on the scale at the reference strapping level.

The instrument including digital device with laser beam element shall have a resolution of at least 1:20 000 and be equipped with a telescope with a magnification of not less than 20. The pentaprism attachment for use with an engineer's level or engineer's theodolite shall not introduce any significant collimation errors.

NOTE 2 Optical plummets can be fitted with a single optical train, i.e. a zenith plummet, a double optical train or a single superimposed optical train giving both upward and downward lines of sight, i.e. a nadir/zenith plummet. It is preferable that the plummet does not have any movable elements in its optical train, such as mirrors or pentaprisms, to ensure stability of the line of sight.

5.2.2 Magnetic trolley, of robust construction. Its design shall include the following features.

a) The magnet(s) shall be of sufficient power to ensure that the trolley does not lose contact with the tank shell in conditions of high wind or when ring joints need to be negotiated or when there are heavy layers of paint or scale.

b) The magnet(s) shall be adjustable for height so that the clearance between the magnet faces and the tank may be varied to suit the tank construction and condition.

c) Manual magnetic trolley shall have a cord or wire cable attached to enable it to be raised or lowered from the tank roof or via a pulley system, from ground level. Automatic magnetic trolley can be moved up and down by electronic motor built in and controlled by remote control.

d) A graduated scale or laser receiving element to indicate the actual offset measurement shall be attached securely to the trolley at its centreline. When the trolley is in its operational mode, the scale shall be either perpendicular to the tank shell or horizontal.

e) The scale shall be attached to the trolley as closely as possible to the centreline of an axis in order to reduce errors caused by deformations in the tank.

NOTE Trolleys that are not magnetic can be used to maintain contact with the tank shell.

5.2.3 Graduated scale, made of steel and marked in millimetre increments. The length of the scale shall be as short as is practicable and shall be determined by the distance at which the optical equipment can be set up from the tank side. The scale shall be calibrated to a resolution of 1 mm or better using standard methods and standard reference devices.

5.3 Electro-optical distance-ranging (EODR) method

Equipment to use shall comply with description made in ISO 7507-4.

6 Procedure

6.1 Principle

This calibration method is based on the accurate measurement of a reference circumference using a calibrated measuring tape at one level on an accessible, non-obstructed course. Repeat measurements agreeing within specified tolerances are made to avoid any systematic error in the derived circumferences. The derived circumferences are calculated from the measured reference circumference, and measurements of offsets taken at the specified levels and at the reference circumference. These offsets are a measure of the deviation of the tank wall. They are measured at a specified number of vertical stations, spaced equally around the tank.

NOTE For examples see Figures 1 to 3.

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6.2 Preparation of the tank

For new tanks or for tanks after repair, fill the tank to its normal working capacity with water or liquid intended to be filled during normal operation at least once and allow it to stand for at least 24 h prior to calibration.

If the tank is calibrated with liquid in it, record the depth, temperature and density of the liquid at the time of calibration. Do not make transfers of liquid during the calibration.

For floating-roof tanks where offset measurements may be taken internally, the roof shall be in its lowest position, resting on the legs.

6.3 Reference circumference

Reference circumference has a direct impact on the calibrated volume of entire tank. It shall therefore be measured as accurately as possible.

Determine the reference circumference using the reference method described in ISO 7507-1 and the following.

a) Take multiple measurements of the reference circumference either prior to the commencement or after the completion of the optical readings. If the first three consecutive measurements agree within the tolerances specified in Clause 7, take their mean average as the reference circumference and their standard deviation as the standard uncertainty. If they do not agree within the tolerances specified in Clause 7, repeat the measurements until two standard deviations of the mean of all measurements is less than the half of the tolerances specified in Clause 7. Use the mean as the measured reference circumference and the standard deviation as the standard uncertainty. Use standard procedures to eliminate obvious outliers.

b) Take the measurement of the reference circumference at a position where work conditions allow reliable measurements, and which is within the focal range of the optical instrument. Strap the tank, aiming at one of the following levels:

   1) 1/4 of the course height above the lower horizontal seam,

   2) 1/4 of the course height below the upper horizontal seam;

and repeat the measurement to achieve measurements agreeing within the tolerances specified in Clause 7.

6.4 Offset readings by optical reference line method

6.4.1 Set up the optical-reference-line device (5.2.1), magnetic trolley (5.2.2) and graduated scale (5.2.3) successively at the horizontal stations (see 6.4.2) that are equally spaced around the tank, as close as possible to the tank wall. Reference lines shall be chosen such that the trolley does not run over a vertical seam or its weld. The graduated scale board should be attached to the trolley with the zero reading closest to the tank shell for both external and internal offset measurements.

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