INTERNATIONAL STANDARD

ISO 4269

First edition
2001-03-15

Petroleum and liquid petroleum products — Tank calibration by liquid measurement — Incremental method using volumetric meters

Pétrole et produits pétroliers liquides — Jaugeage des réservoirs par épalement — Méthode par empotement utilisant des compteurs volumétriques

Reference number
ISO 4269:2001(E)

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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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 4269 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 3, *Static petroleum measurement*.

Annex A forms a normative part of this International Standard. Annex B is for information only.

Introduction

This International Standard forms part of a series on tank calibration including the following:

ISO 7507-1, ISO 7507-2, ISO 7507-3, ISO 7507-4, ISO 7507-5, ISO 7507-6, ISO 8311, ISO 9091-1 and ISO 9091-2.

Liquid calibration methods may be used in the calibration of either the total or partial capacity of a tank. A high degree of accuracy may be obtained provided that great care is taken at all stages of the operation. The method is particularly useful where tanks are of irregular shape, for the calibration of the bottom of any storage tank, or for the calibration of ship and barge tanks having irregular cross sections.

The method offers a degree of accuracy which may exceed other methods when used in the calibration of small tanks, especially small horizontal cylindrical tanks.

The calibration liquid may be either water or a suitable petroleum product having a low volatility and viscosity. Water is recommended where wide temperature variations are expected during calibration as water has a low coefficient of cubical expansion. However, the use of water may introduce unacceptable risks and difficulties depending on the use to which the tank being calibrated is to be put (e.g. the use and subsequent removal of water when used in the calibration of underground storage tanks at retail sites). In such circumstances the use of a suitable petroleum product would be preferable.

Petroleum and liquid petroleum products — Tank calibration by liquid measurement — Incremental method using volumetric meters

1 Scope

This International Standard specifies a method for the calibration of tanks by addition of batches of liquid. The liquid is used as a volume-transfer medium, measured accurately by means of a meter.

This International Standard is not applicable to the calibration of reference measuring instruments, proving tanks, or meter provers.

NOTE Applicable standards are given in the bibliography.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard 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 91-1:1992, *Petroleum measurement tables — Part 1: Tables based on references temperature of 15 °C and 60 °F*.

ISO 91-2:1991, *Petroleum measurement tables — Part 2: Tables based on a reference temperature of 20 °C*.

ISO 2714:1980, *Liquid hydrocarbons — Volumetric measurement by displacement meter systems other than dispensing pumps*.

ISO 2715:1981, *Liquid hydrocarbons — Volumetric measurement by turbine meter systems*.

ISO 4268, *Petroleum and liquid petroleum products —Temperature measurements — Manual methods.*

ISO 7507-1:1993, *Petroleum and liquid petroleum products — Calibration of vertical cylindrical tanks — Part 1: Strapping method*.

ISO/TR 7507-6:1997, *Petroleum and liquid petroleum products — Calibration of vertical cylindrical tanks — Part 6: Recommendations for monitoring, checking and verification of tank calibration and capacity tables*.

ISO 9770:1989, *Crude petroleum and petroleum products — Compressibility factors for hydrocarbons in the range 638 kg/m^3 to 1074 kg/m^3*.

IEC 60079-10, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas*.

3 Terms and definitions

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

3.1
K-factor
number of pulses generated by a meter per unit of volume passing through it

3.2
pre-set device
equipment which shuts off the delivery of calibration liquid to the meter after a predetermined volume has passed through the meter

4 Precautions

4.1 The general precautions and safety precautions in ISO 7507-1 and IEC 60079-10 shall apply to this International Standard.

4.2 When a petroleum product is used as the calibration liquid, the following additional safety precautions, which are not exhaustive, shall be observed:

a) control of sources of ignition;

b) prevention of electrostatic accumulation by

1) the correct bonding of transfer hoses,

2) control of pumping speeds,

3) prevention of free fall and splashing of liquid,

4) maintenance of the velocity of the liquid in the line below 1 ms^{-1} until the end of the filling pipe is submerged.

5 Meters

5.1 General specifications

5.1.1 The meter shall be of the positive displacement or turbine type.

5.1.2 The meter shall be fabricated from materials suitable for the calibration liquid to be used.

5.1.3 The meter shall be selected so that the flow rate, at which the meter will operate during the tank calibration, is within the linear range of the meter factor curve of the meter.

The meter should either be fitted with a flow-rate indicator, or average flow rates should be calculated by timing deliveries by means of a stop watch.

5.1.4 The meter shall have either a device giving a read-out in volumetric units or an electronic pulse counter used to calculate volume.

To enable the required repeatability to be determined during the proving of the meter, and depending on the volume passed by the meter during such proving, a special counter or other indicator capable of being read to a fraction of the unit of volume should be provided.

5.1.5 A volumetric proving tank, a pipe prover or a small volume prover, suitable for use with the type of meter chosen, shall be provided for calibrating the meter. The selected apparatus shall be provided with a calibration certificate showing any corrections which may be required when in use.

5.1.6 A thermowell (thermometer pocket) shall be provided in the metering system adjacent to the meter.

To ensure adequate immersion and thermal response, and to avoid undesirable thermal conduction effects from the pipe wall, it is recommended that, particularly in the case of small diameter lines, the pocket should be installed in the body of the meter if a positive displacement meter is used. If a turbine meter is used, then the thermowell shall be installed in the pipework at least five pipe diameters downstream of the meter position. The thermowell should be in direct contact with the calibration liquid and should be filled with a light oil to aid thermal response. The thermowell, and the fitting in which the sensitive element of the thermometer is immersed, should be designed in accordance with sound thermo-technical principles. It may be desirable to provide external insulation round the pipe or fitting at the position of, and adjacent to, the thermowell.

5.1.7 A rapid operating valve or shut off device shall be installed downstream of the meter (see 6.4.5).

5.2 Positive displacement meters

The meter factor shall not deviate by more than ± 0,20 % from the average meter factor between 10 % and 100 % of the maximum rated flow rate of the meter.

5.3 Turbine meters

5.3.1 The K-factor shall not deviate by more than ± 0,20 % between 10 % and 100 % of the maximum capacity of the meter.

5.3.2 A back pressure in excess of 100 kPa (gauge) shall be applied in order to prevent cavitation.

5.4 Selection of meter

5.4.1 The selection of a meter for tank calibration is contingent on the following:

a) the operating rate of flow to be used when calibrating the tank (see 5.4.4);

b) the maximum pressure to which the meter will be subjected;

c) the liquid which the meter is required to measure (see 5.1.2);

d) the temperature range over which the meter will operate;

e) the range of viscosities over which the meter will operate.

5.4.2 Meters incorporating a temperature compensator shall not be used for tank calibration.

5.4.3 The meter shall be provided with a meter factor or K-factor curve (error–flow curve) for the type of liquid, viscosity, temperature and range of flow rates over which it will be used.

5.4.4 The repeatability of the meter shall be such that the results of five consecutive proving runs shall be within a range of ± 0,025 % of the average after correcting for temperature, pressure and viscosity.

5.4.5 Meters shall be installed and operated in accordance with the appropriate recommendations contained in ISO 2714 or ISO 2715.

6 Apparatus

6.1 Dip-tape and dip-weight

This shall be as specified in ISO 7507-1:1993, B.6 and B.7.

6.2 Ullage paste

NOTE The term "oil-finding paste" is synonymous.

6.3 Water-finding paste

6.4 Ancillary equipment

6.4.1 Air/vapour separator

An air separator, when utilized, shall be fitted upstream of the meter.

A back-pressure valve may be required to maintain an adequate pressure drop across the air release valve fitted to the air separator.

6.4.2 Flow limiter

A flow limiting device shall be fitted in the line, downstream of the meter, to limit the rate of flow if the pressure of the calibration liquid supply is such that the flow rate through the installation is too great for the rated capacity of the meter.

6.4.3 Pre-set device

The pre-set device should be leak proof and operate quickly with a smooth action, without causing any undue pressure surge.

6.4.4 Pressure gauge

Where a positive displacement meter is used, a pressure gauge shall be mounted in the line as close to the meter as possible, preferably on the downstream side. Where a turbine meter is used, a pressure gauge shall be installed at least five pipe diameters downstream from the meter. It may be preferable that two pressure gauges are installed equidistant from the meter upstream and downstream

6.4.5 Shut-off valve

The valve shall be leak proof, and shall operate quickly with a smooth action and without causing an undue pressure surge.

If a pre-set device is not fitted, a shut-off valve, to shut off the flow at the required intervals, shall be installed downstream of the meter.

6.4.6 Strainer

6.4.7 Surge suppressor

If surge pressures are likely to occur, a suitable surge suppressor should be fitted to the line.

6.4.8 Syphon breaker

If fitted, the syphon breaker shall be downstream of the meter as close to the delivery point as is possible.

When a tank is being calibrated by top filling, then the syphon breaker should be installed in conjunction with a weir. The assembly should be fitted at the highest point in the system.

6.4.9 Viewing glass

A viewing glass shall be provided adjacent to/in the air separator if utilized.

6.4.10 Weir

If installed, the weir shall be positioned in such a way as to ensure that the delivery pipe downstream of the meter is full at all times.

7 Calibration procedure

7.1 General requirements

7.1.1 A tank shall only be calibrated after it has been filled at least once with a liquid of density equal to or greater than that which it will hold when in use.

NOTE The hydrostatic test applied to new or repaired tanks will satisfy this requirement in most cases.

7.1.2 Before commencing calibration, the system shall be checked for leakage downstream of the meter. Any leaks found shall be eliminated.

7.1.3 The serial numbers, or identification marks, of thermometers used in the course of calibration shall be recorded together with their location during the calibration. The thermometers shall be calibrated in accordance with ISO 4268 and shall be provided with a certificate showing corrections.

7.1.4 Care shall be exercised to avoid the ingress of air into the system when using a meter to calibrate a tank.

It is important that the meter, ancillary equipment and lines be liquid filled before the commencement of calibration.

7.1.5 If fitted, a strainer/filter shall be installed in the line upstream of the meter to protect the meter from abrasion or other damage from entrained foreign matter.

7.1.6 If the variation of the volume of calibration liquid in the hose connecting the meter to the tank, compared with the total volume of liquid in the tank, is such that the accuracy of the calibration would be significantly affected, a syphon breaker shall be placed at the end of the hose to ensure that the hose remains filled with a constant quantity of liquid.

7.1.7 Excessive variations in the temperature of the calibration liquid shall be avoided if the required accuracy is to be maintained.

Large fluctuations make it difficult to determine an accurate mean temperature and this in turn causes the following:

a) uncertainties in applying the volume correction factors to the liquid;

b) uncertainties in applying the correction factor for the expansion/ contraction of the measuring equipment;

c) uncertainties in applying the correction factor for the expansion/ contraction of the tank being calibrated.

7.1.8 An adequate supply of the calibration liquid shall be available. The pressure available shall be sufficient, at all times, to maintain stable flow rates within the normal operating range of the meter.

7.1.9 If a petroleum product is used as the calibration liquid, its depth in the tank shall be measured with product-finding paste applied in a smooth even film to the dip-tape and dip-weight.

7.1.10 If water is used as the calibration liquid, its depth in the tank shall be measured with water-finding paste applied in a smooth even film to the dip-tape and dip-weight.

7.1.11 The exact height of the upper reference point above the dip-point shall be determined at the time of calibration. The overall dipping height shall be marked on the roof of the tank at or near to the dip hatch to which it applies.

In tanks with a single dip point, the upper reference point shall be clearly marked on the tank and its height above the dipping datum point shall be recorded at the head of the table. In tanks with more than one dip point, the overall height at each dip point shall be clearly marked adjacent to the point. This measurement may require adjustment to correct for the difference between the actual and the certified reference temperature of the dip-tape and dip-weight used to measure the overall dipping height. The correction shall be calculated in accordance with the equation given in A.3.

7.1.12 If the calibration of the tank is interrupted, it may be resumed at a later date provided that

a) if there is a change of equipment or personnel, sufficient check measurements are made to ensure that the results obtained prior to the changes correspond within the tolerances laid down in this method,

b) all records of work previously carried out are complete and legible, and

c) the new liquid mean temperature and depth at resumption of operations are recorded.

7.2 Equipment

The calibration of a tank may not necessarily require all of the equipment listed in clause 6. The requirements for each operation shall be considered before selecting equipment.

7.3 Installation

7.3.1 Figure 1 shows a schematic diagram of a typical installation for calibration by meter.

7.3.2 Attention shall be paid to pipework to ensure minimum pressure drop and turbulence.

Any condition which tends to increase the turbulence of the liquid stream should be avoided.

7.3.3 The meter shall be installed in such a manner that no undue strain is imposed upon it due to the mass or thermal expansion/contraction of the pipework.

7.3.4 Flexible hoses may be used to provide a supply of liquid for calibration purposes. If they are used on the downstream side, the total length shall be kept to a minimum.

7.4 Meter proving

7.4.1 The meter shall be proved, on site, using either a volumetric prover tank, meter or pipe prover.

Proving should preferably be carried out using the same fluid as that in the tank.

7.4.2 Proving shall be carried out, as a minimum, immediately prior to commencement and on completion of any calibration. If the calibration process extends over more than one day, the meter shall be proved at commencement of calibration and on completion of calibration on each day. Proving may be carried out at shorter intervals to ensure that the meter or K-factor has not drifted.

NOTE Proving at a central proving station/installation may be acceptable if meters are proved under conditions which closely replicate those encountered at the calibration site.