INTERNATIONAL STANDARD

ISO 3170

Third edition
2004-02-01

Petroleum liquids — Manual sampling

Produits pétroliers liquides — Échantillonnage manuel

Reference number
ISO 3170:2004(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.org
Web www.iso.org

Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 3170 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 3, *Static petroleum measurement*.

This third edition cancels and replaces the second edition (ISO 3170:1988), which has been technically revised.

The principal technical changes include the addition of

— procedures for tank sampling under restricted and closed system conditions, and

— procedures for the taking of manual spot samples from pipelines containing high vapour pressure liquids.

Introduction

This International Standard may be applied in combination with ISO 3171.

The purpose of this International Standard is to standardize conditions for obtaining a sample of liquid/semi-liquid hydrocarbons from a tank, drum or pipeline by manual means. If the hydrocarbon to be sampled is of non-homogeneous character showing significant variations in composition or containing sediments and water, samples taken manually should not be expected to be representative, but may enable the degree of non-homogeneity to be assessed and estimates of quality and quantity to be made.

Procedures are specified which minimize or eliminate losses of light ends from samples. Such losses can occur during handling or transfer of samples, thereby making them non-representative of the bulk.

The procedures specified are intended to provide samples for the following purposes:

a) the determination of the liquid/hydrocarbon quality;

b) the determination of the water content;

c) the determination of other contaminants that are not considered to be part of the liquid transferred.

If the sampling conditions for purposes a), b) and c) are in conflict, separate samples are required.

Sampling procedures for tank contents that are not homogeneous are specified that enable the degree of non-homogeneity to be assessed and estimates of quality and quantity to be made.

Procedures for the tank sampling of liquid hydrocarbons under inert gas pressure are included, together with techniques for sampling from tanks which are equipped with vapour emission control systems.

It is recognized that, in many countries, some or all of the items covered by this International Standard are the subject of mandatory regulations imposed by the laws of those countries. In cases of conflict between such mandatory regulations and this International Standard, the former prevail.

Petroleum liquids — Manual sampling

1 Scope

This International Standard specifies the manual methods to be used for obtaining samples of liquid or semi-liquid hydrocarbons, tank residues and deposits from fixed tanks, railcars, road vehicles, ships and barges, drums and cans, or from liquids being pumped in pipelines.

It applies to the sampling of petroleum products, crude oils and intermediate products, which are stored in tanks at or near atmospheric pressure, or transferred by pipelines, and are handled as liquids at temperatures from near ambient up to 200 °C.

The sampling procedures specified are not intended for the sampling of special petroleum products which are the subject of other International Standards, such as electrical insulating oils (IEC 60475), liquefied petroleum gases (ISO 4257), liquefied natural gases (ISO 8943) and gaseous natural gases (ISO 10715).

This International Standard refers to existing methods of sampling and the type of equipment presently in use. It is, however, not intended that it should exclude the use of new equipment not yet developed for commercial use, provided that such equipment enables samples to be obtained in accordance with the requirements and procedures of this International Standard.

NOTE For the purposes of this International Standard, the term "% (m/m)" is used to represent the mass fraction.

2 Normative references

The following referenced documents are indispensable for the application 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 1998 (all parts), *Petroleum industry — Terminology*

ISO 2859-1:1999, *Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality limit (AQL) for lot-by-lot inspection*

ISO 3171:1988, *Petroleum liquids — Automatic pipeline sampling*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1998 and the following apply.

3.1
acceptable quality level
AQL
maximum per cent defective (or the maximum number of defects per hundred units) that, for purposes of sampling inspection, can be considered satisfactory as a process average

3.2
all-level sample
sample obtained with an apparatus which accumulates the sample while passing in one direction only through the total liquid height, excluding any free water

3.3
automatic sampler
device used to extract a representative sample from the liquid flowing in a pipe

NOTE The automatic sampler generally consists of a probe, a sample extractor, an associated controller, a flow measuring device, and a sample receiver.

3.4
batch
collection of packages containing a product of a single type and composition and of a single manufactured lot, or of a single delivery

3.5
bottom sample
spot sample taken from the product at or close to the bottom of a tank or container

See Figure 1.

3.6
bottom water sample
spot sample of free water taken from beneath the petroleum in a tank

3.7
closed sampling
process of taking samples within a tank under closed conditions, which does not permit the release of any tank contents or vapour to the atmosphere

3.8
composite sample
sample obtained by combining a number of spot samples in defined proportions so as to obtain a sample representative of the bulk of the product

3.9
dipper sample
sample obtained by placing a dipper or other collecting vessel in the path of a free-flowing stream to collect a definite volume from the full cross-section of the stream at regular time intervals for a constant time rate of flow, or at time intervals varied in proportion to the flow rate

NOTE This method is normally restricted to sampling petroleum coke from conveyor belts.

3.10
drain sample
sample obtained from the water draw-off valve on a storage tank

NOTE Occasionally, a drain sample may be the same as a bottom sample, for example, in the case of a tank car.

3.11
floating roof sample
spot sample taken just below the surface to determine the density of the liquid on which the roof is floating

3.12
grease sample
spot sample obtained by scooping or dipping a quantity of soft or semi-liquid material from a container

3.13
integrity of the sample
condition of being complete and unaltered, i.e. the sample being preserved with the same composition as when it was taken from the bulk of the liquid

3.14
lower sample
spot sample taken at a level of five-sixths of the depth of liquid below the top surface

See Figure 1.

3.15
middle sample
spot sample taken at a level of one-half of the depth of liquid below the top surface

See Figure 1.

3.16
mixer
device which provides a homogeneous mixture of the liquid within a pipeline or container in order to obtain a representative sample

3.17
open sampling
process of taking traditional samples within a tank via an open gauge hatch or gauging access point

NOTE If the tank ullage space is pressurized, it will normally be necessary to use other (closed or restricted) procedures to avoid de-pressurizing the tank and the consequent loss of volatile organic compounds (VOCs).

3.18
per cent defective

one hundred times the number of defective units of product contained in any given quantity of units of product divided by the total number of units of product inspected, i.e.:

$$\text{per cent defective} = \frac{\text{number of defectives}}{\text{number of units inspected}} \times 100$$

3.19
portable sampling device
PSD
housing designed to provide a gas-tight connection to a vapour-lock valve, which contains a restricted or closed system sampler and is fitted with a tape or cable winding mechanism for lowering and retrieving the sampler

3.20
representative sample
sample having its physical or chemical characteristics identical to the volumetric average characteristics of the total volume being sampled

3.21
residues and deposits
organic and inorganic matter, together with any water dispersed within it, which has separated from the liquid and either fallen to the bottom of the tank containing the liquid, or been left in the tank after the liquid has been pumped out

3.22
restricted sampling
process of taking samples within a tank using equipment which is designed to substantially reduce or minimize the vapour losses that would occur during open sampling, but where the equipment is not completely gas-tight

3.23
running sample
sample obtained with an apparatus which accumulates the sample while passing in both directions through the total liquid height, excluding any free water

3.24
sample conditioning
mixing necessary to homogenize the sample during sample handling in preparation for subsampling and/or analysis

3.25
sample handling
any conditioning, transferring, dividing and transporting of the sample

NOTE Sample handling includes transferring the sample from the primary sampling device to any secondary container, and the transferring of subsamples to the laboratory apparatus in which it is to be analyzed.

3.26
sample size
number of samples to be drawn from a batch to determine its acceptability as given in sampling plans

3.27
skim sample
surface sample
spot sample taken from the surface of the liquid

See Figure 1.

3.28
spot sample
sample taken at a specific location in a tank or from a flowing stream in a pipe at a specific time

3.29
static mixer
mixing device having no moving parts and located within a pipe or tube

NOTE The effectiveness of the static mixer depends on the kinetic energy of the moving liquid for the energy required to mix the liquid.

3.30
still-well
guide pole
still-pipe
sounding-pipe
stand pipe
vertical cylindrical pipe built into a tank to permit gauging operations while reducing errors arising from turbulence or agitation of the liquid

NOTE 1 Samples taken from unperforated or unslotted still-wells should not be used for custody transfer applications, see 7.2.1.3.

NOTE 2 Still-wells may also be found on ships and barges.

3.31
suction-level sample
outlet sample
sample taken at the lowest level from which liquid hydrocarbon is pumped from the tank

See Figure 1.

NOTE In determining this level, appropriate allowance is made for any fittings within the tank such as swing-arm, suction baffle or internal bend.

3.32
sump sample
spot sample taken from within a sump

3.33
suspended water
water within the oil that is finely dispersed as small droplets

NOTE It may, over a period of time, either collect as free water or become dissolved water, depending on the conditions of temperature and pressure prevailing.

3.34
tap sample
tank-side sample
spot sample taken from a sample tap on the side of a tank

3.35
test portion
portion of a sample or subsample that is introduced into the analytical test apparatus

3.36
top sample
spot sample obtained 150 mm below the top surface of the liquid

See Figure 1.

3.37
total water
sum of all the dissolved, suspended and free water in a cargo or parcel of oil

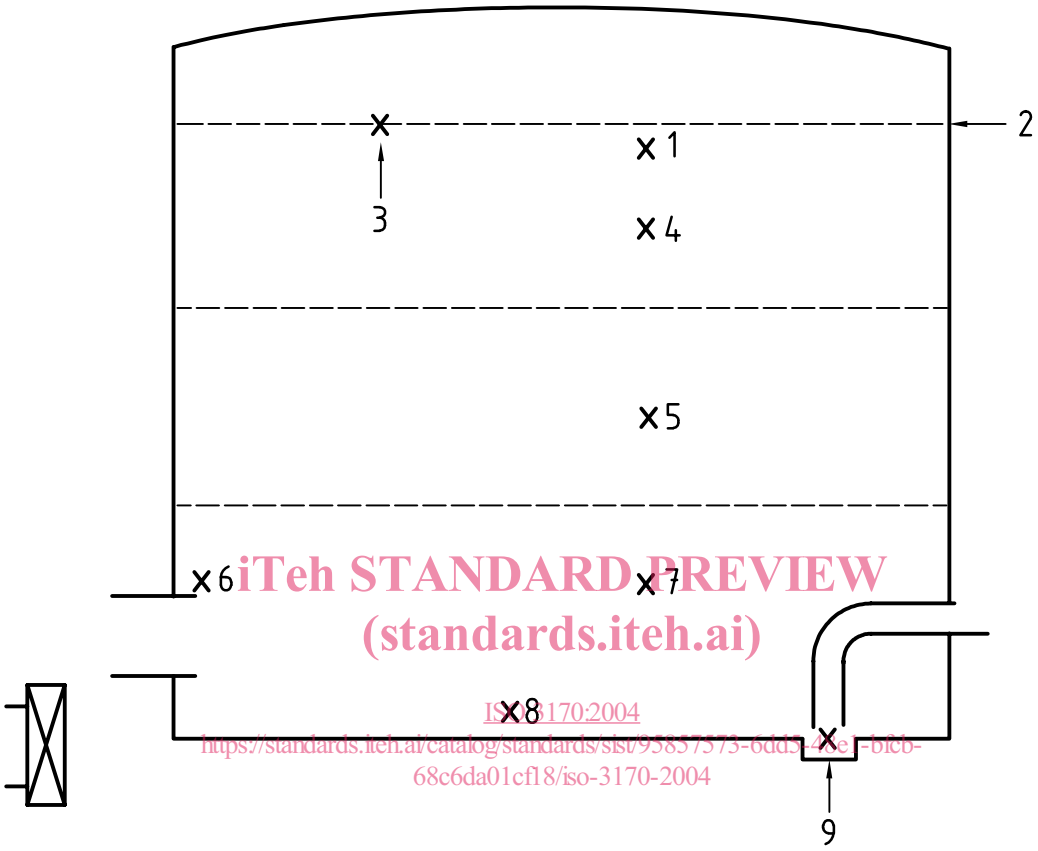
3.38
ullage
empty capacity left in a fixed volume sample receiver/container above the liquid surface

3.39
upper sample
spot sample taken at a level of one-sixth of the depth of liquid below the top surface

See Figure 1.

3.40
vapour-lock valve
vapour control valve
device fitted to the top of vapour-tight or pressure tanks to permit manual measurement and/or sampling operations to be carried out without loss of pressure

3.41
zone sample
core sample
flow-through sample
sample taken as that part of the liquid column which is trapped within the whole height of a sampler when it is sealed at a single spot location within a tank, after having been fully flushed as it was lowered to that position



Key

1 top sample
2 surface of oil
3 skim sample
4 upper sample
5 middle sample
6 suction level or outlet sample
7 lower sample
8 bottom sample
9 sump sample

Figure 1 — Examples of spot sample positions

4 Principles

4.1 To ensure that samples submitted for examination are as representative as possible of the liquid being sampled, the necessary precautions are given. These depend on the characteristics of the liquid, the tank, container or pipeline from which the sample is being obtained, and the nature of the tests to be carried out on the sample.

Two basic manual sampling methods are available:

— tank sampling (static sampling);

— pipeline sampling (dynamic sampling).

When a batch is received or consigned, either tank or pipeline sampling, or both, may be possible. However, if both methods are used, the two sets of samples shall not be mixed.

4.2 Tank sampling is commenced when the contents of the tank are at rest. The following types of samples are normally taken for analysis:

a) upper, middle and lower samples, or

b) upper, middle and suction-level (outlet) samples.

If tests on these samples show that the contents of the tank are homogeneous, they may be combined, in proportion to the volume that each sample represents, for further tests.

If the tests on these samples show that the contents of the tank are non-homogeneous, it may be necessary to draw spot samples from more than three levels and either a composite sample is prepared for analysis or, if blending would impair the integrity of the sample, each sample is analysed separately and the composition corresponding to the composite sample is calculated. In this calculation, allowance is made for the proportion of the oil represented by each sample. Examples of spot sample positions are shown in Figure 1.

Other methods are a running sample or an all-level sample.

As both these methods only result in a single sample, they cannot be used to assess the homogeneity (or otherwise) of a tank’s contents. Running and all-level samples are commonly taken and used to determine the average quality of a tank's contents.

NOTE 1 Safety and environmental regulations may restrict tank sampling operations which can result in the release of hydrocarbons or other volatile organic compounds (VOCs) into the atmosphere. In these circumstances, it will not normally be feasible to use traditional open sampling procedures via an open gauge hatch or gauging access point. If the tank ullage space is pressurized, and/or the tank forms part of a vapour balancing/recovery system, it will normally be necessary to use closed or restricted sampling procedures to avoid de-pressurizing the tank and minimize the consequent loss of VOCs. If the vapour from the tank contents is hazardous, it will also normally be necessary to use closed or restricted sampling procedures to minimize the risk of environmental impact.

NOTE 2 Closed sampling is the process of taking samples within a tank using closed sampling devices under closed system conditions. A closed system exists when the operations do not permit the direct exposure and/or release of any tank contents to atmosphere. Manual closed sampling is therefore normally carried out via a vapour-lock valve, using a closed sampling device that provides a gas-tight seal when in use. In order to ensure that no residual vapour is released from a closed system, special facilities may be provided to displace any vapour held up within the device prior to disconnecting the sampling device from the vapour-lock valve.

NOTE 3 Restricted sampling is the process of taking samples within a tank using a restricted sampling device that is operated via a vapour-lock valve. Restricted equipment is designed to substantially reduce or minimize the vapour losses that would occur during open sampling, but may still allow a small quantity of vapour to escape because the equipment is not completely gas-tight.

4.3 To obtain a representative sample of a batch/parcel transfer quantity being pumped in a pipeline, the sample is drawn using an automatic sampling device in accordance with ISO 3171. On occasions, it may be necessary to take dynamic pipeline samples manually. These are spot samples and may not be representative of the bulk (see 7.4).

5 Apparatus

5.1 General

All sampling devices shall be designed to be leak-tight, and constructed so as to assure the function for which they are intended in order to maintain the initial characteristics of the oil. They shall be of sufficient strength and externally protected to withstand normal internal pressures likely to be generated, and sufficiently robust to withstand any handling that may be encountered. Their cleanliness shall be confirmed before use.

NOTE 1 In some cases, it may be desirable to rinse the sample receiver/equipment with the fluid that is to be sampled, prior to taking the actual sample (although this will normally only be practicable with liquid hydrocarbons).

NOTE 2 Various sampling devices are described in 5.2 to 5.7 and any essential aspects are specified. Detailed specifications have not been given for these items because any suitable device of the type described may be used.

5.2 Tank samplers

5.2.1 General

Tank samplers are classified according to the type of sample to be drawn, these are

— spot sample,

— zone/core sample,

— running sample, and

— all-level sample.

Tank samplers are also classified according to the mode of tank operation and sampling access, these are

— open (traditional) sampling,

— restricted sampling, and

— closed sampling.

Synthetic fibre cords shall not be used for lowering or raising tank samplers through the tank contents as they can generate electrostatic sparks.

NOTE Chains are not recommended for suspending samplers because earth continuity cannot be guaranteed.

5.2.2 Spot and zone samplers

5.2.2.1 General

Spot and zone samplers shall be constructed so that a sample can be taken at any specific level in a tank. The equipment described in 5.2.2.2 to 5.2.2.4 is suitable.

NOTE Other spot sampling devices are available and may be used. Some have special opening facilities, for example, having valves opened or closed at the desired level by a weight falling down alongside and guided by the suspending cable, or having wing or flap valves which are closed upon initiation of upward movement. Some are designed to be operated when deployed via a vapour-lock valve (restricted and closed system samplers).

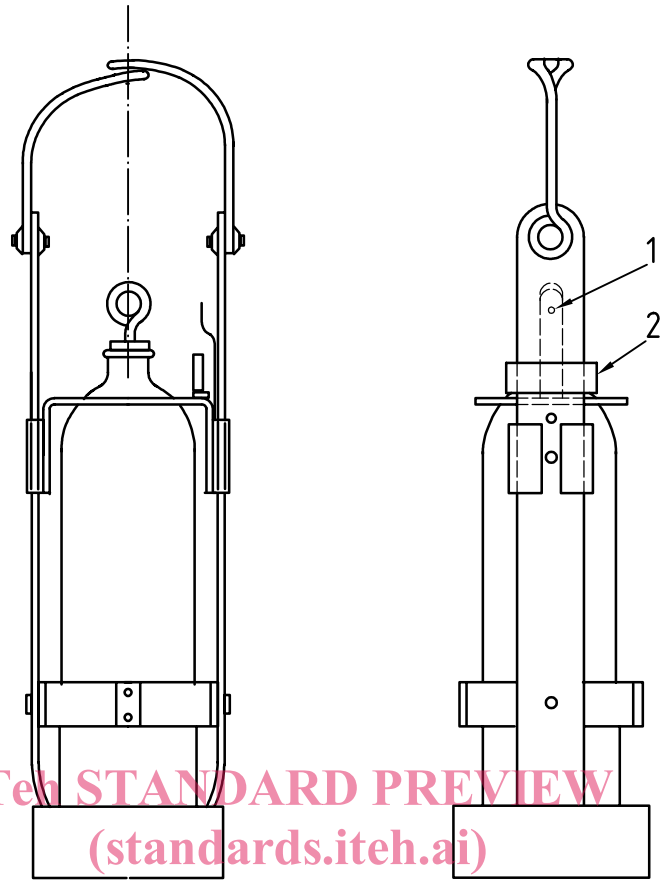
5.2.2.2 Sampling cage

A sampling cage shall be a metal or plastics holder or cage, suitably constructed to hold the appropriate container, typically a bottle or can. The combined apparatus shall be weighted so as to sink readily in the product to be sampled, and provision shall be made to fill the container at any desired level (see Figure 2).

Sampling cages should be sized to fit the desired sample bottle size. Some designs of bottle cage can accept a variety of different neck size (and volume) bottles, and incorporate a floating ball system to seal the bottle once it has been filled.

NOTE 1 The use of a sampling bottle cage is preferred to other spot sampling methods for volatile products, since it avoids the loss of light ends that is likely to occur when transferring the sample to another container.

NOTE 2 The sampling cage may be omitted if the sample bottle is securely attached to a weighted cord. The cork is also tied to the line about 150 m from the neck of the bottle.



Key

1 swivel point
2 locking piece

Figure 2 — Example of a sample-bottle cage