

Petroleum liquids — Automatic pipeline sampling — Statistical assessment of performance of automatic samplers determining the water content in hydrocarbon liquids

ICS 75.080

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PTI/12, Petroleum measurement and sampling, to Subcommittee PTI/12/1, Static and dynamic petroleum measurement, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the ISO/TR title page, pages ii to iv, pages 1 to 27 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.

Amendments issued since publication

Amd. No.	Date	Comments

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TECHNICAL REPORT

**ISO/TR
9494**

First edition
1997-12-15

Petroleum liquids — Automatic pipeline sampling — Statistical assessment of performance of automatic samplers determining the water content in hydrocarbon liquids

*Produits pétroliers liquides — Échantillonnage automatique en oléoduc —
Estimation statistique des performances d'échantillonneurs automatiques
pour déterminer la teneur en eau dans les hydrocarbures liquides*



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Descriptors: Petroleum products, liquids, crude oil, oil pipelines, sampling, estimation, performance, rules of calculation, statistical analysis.

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 main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report for one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard (« state of the art », for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 9494, which is a Technical Report of type 3, was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 3, *Static petroleum measurement*.

In publishing this text, the committee was aware that the terminology used in this Technical Report in connection with measurement uncertainty, and the methods used to evaluate and express measurement uncertainty, are not consistent with the *Guide to the Expression of Uncertainty in Measurement*. Nevertheless it is believed that it will still serve as a helpful aid to those who have to implement ISO 3171, in particular clause 16.

It is envisaged that at the first revision of this Technical Report the opportunity will be taken to align it with the *Guide to the Expression of Uncertainty in Measurement*.

1 Scope

This Technical Report describes a mathematical method for assessing the overall uncertainty of automatic sampling systems for determining the water content in oil being transferred through pipelines.

The model estimates the overall uncertainty. (tolerance) by combining statistically the individual systematic and random uncertainties of a number of individual component variables defined in an automatic “grab” type sampling system.

The tolerances on water content determination as a function of the number of sampling grabs, the water content, and the number of water analyses performed are summarized in graphics form (see Figure 6 – Figure 11).

It serves as technical support for clause 16 of ISO 3171.

2 Normative references

The following standards contain provisions, which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3171:1988, *Petroleum liquid — Automatic pipeline sampling*.

RENYI. Calculation of probabilities. Dunod, 1966

3 Definitions of symbols

w , w subscripted	= Water content in the pipeline, in percent volume/volume (v/v)
P_i , q_i , S' , w' , w''	= Water content in the various parts of the sampler and of the analysis
T_j , T	= Estimates of water content
V , V_i	= Volume of fluid passing through the system in the interval between two consecutive grabs
V_i	= Total volume of fluid passing through the straight section from the beginning of sampling up to t_i
W	= Total volume of fluid passing through the straight section
e_i	= Volume of grab
D	= Combined uncertainty of the random uncertainties and systematic uncertainties in “w” — half-width of a symmetrical bilateral confidence interval (with a 95 % confidence level)
n	= Number of analyses
N	= Number of grabs
S , R , L and P	= Derived parameters
$a_s b_s \dots g_s$	= Relative systematic uncertainty on the factors influencing the measurement “w”
$a_r b_r \dots g_r$	= Relative random uncertainty, on the factors influencing the measurement “w”

NOTE The relative uncertainty on x is = $\frac{\text{Uncertainty of } x}{\text{value of } x}$

Where the relative systematic uncertainties and the relative random uncertainties are the following:

— Degree of non-homogeneity of water content, as described in clause 5 and Annex A of ISO 3171:1988 (e.g. poor dispersion)

a_s relative systematic uncertainty

a_r relative random uncertainty

- Distortion of the water content by the sampling system as described in clause 8 of ISO 3171:1988 (e.g. non-isokinetic)
 - b_s relative systematic uncertainty
 - b_r relative random uncertainty
- Uncertainties on the volume of each grab
 - d_s relative systematic uncertainty (not used but see clause 9)
 - d_r relative random uncertainty
- Flowmeter (degree of non-proportionality), as described in clause 10 of ISO 3171:1988 (e.g. variations in the k-factor of correction of the turbine meter)
 - c_s relative systematic uncertainty (not used but see clause 9)
 - c_r relative random uncertainty
- Distortion of water content during sampling, as described in clause 11 of ISO 3171:1988 (e.g. by emulsification or evaporation)
 - h_s relative systematic uncertainty
 - h_r relative random uncertainty
- Distortion of water content due to sample handling and mixing, as described in clause 12 of ISO 3171:1988 (e.g. poor homogenization in the laboratory)
 - f_s relative systematic uncertainty
 - f_r relative random uncertainty
- Distortion of water content due to transfer to laboratory glassware and analysis (e.g. tube graduation error)
 - g_s relative systematic uncertainty
 - g_r relative random uncertainty

The derived parameters are obtained from the following equations:

Sampling

$$S = a_s + b_s + h_s \quad \text{(relative systematic uncertainty)}$$

$$R = \frac{1}{4}(a_r^2 + b_r^2 + c_r^2 + d_r^2) \quad \text{(relative random uncertainty)}$$

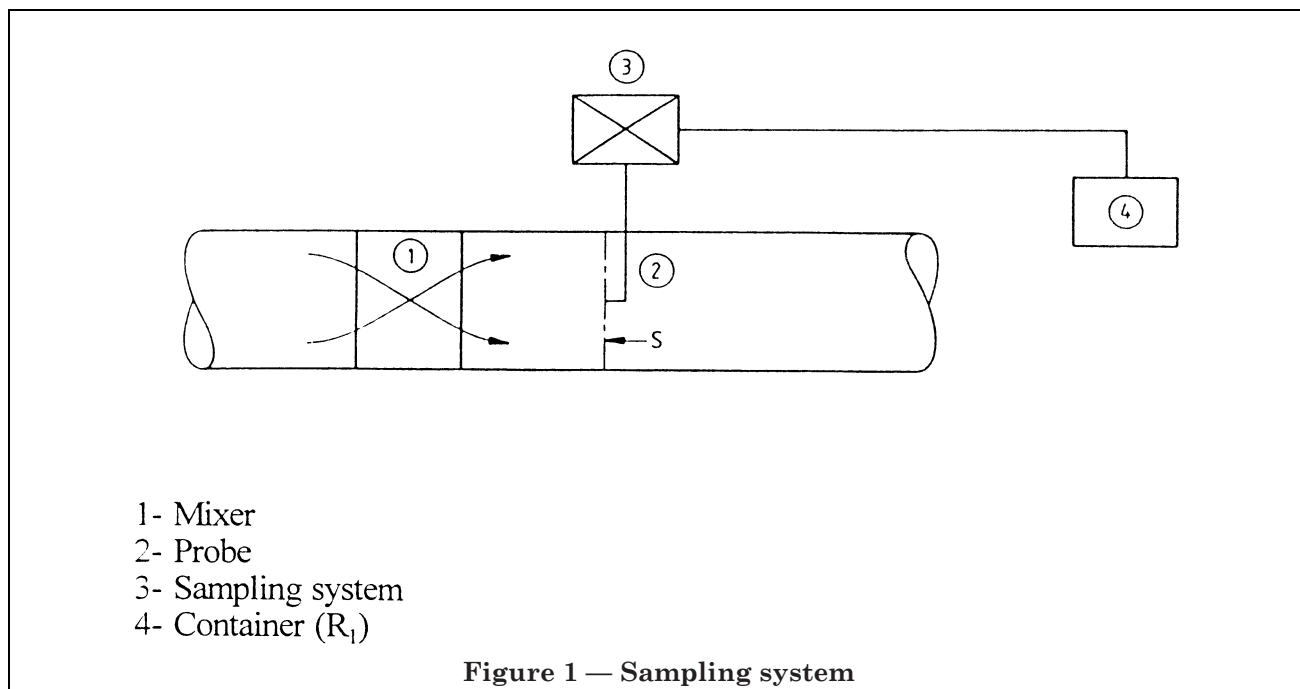
Laboratory

$$L = f_s + g_s \quad \text{(relative systematic uncertainty)}$$

$$P = \frac{1}{4}(f_r^2 + \frac{g_r^2}{n}) \quad \text{(relative random uncertainty)}$$

4 General

The water content w of volume W fluid flowing in a pipeline is estimated by taking N samples (grabs) automatically from a section of the pipeline as illustrated in Figure 1.



The probe of the sampling system is located in a section downstream from the mixer. The sampling moments are controlled by a flowmeter so that the volume of fluid passing through the section between two sampling operations is equal to V , i.e. sampling is proportional to flow.

The N samples (grabs) are collected in the same container (R_1).

The volume, v , of the fluid passing through the section is taken as a variable and $w(v)$, the water content in the section in question, is noted.

In view of the random effects on the flowmeter, the N samples are separated by intervals of fluid volume V_i with $i = 1$ to $N - 1$ (as shown in Figure 2).

