INTERNATIONAL STANDARD

ISO 10414-2

Second edition
2011-06-15

Petroleum and natural gas industries — Field testing of drilling fluids —

Part 2: Oil-based fluids

Industries du pétrole et du gaz naturel — Essais in situ des fluides de forage —

Partie 2: Fluides à base d'huiles

Reference number
ISO 10414-2:2011(E)

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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 10414-2 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for the petroleum, petrochemical and natural gas industries*, Subcommittee SC 3, *Drilling and completion fluids, and well cements*.

This second edition cancels and replaces the first edition (ISO 10414-2:2002), which has been technically revised.

ISO 10414 consists of the following parts, under the general title *Petroleum and natural gas industries — Field testing of drilling fluids*:

— *Part 1: Water-based fluids*

— *Part 2: Oil-based fluids*

Introduction

This part of ISO 10414 is based on API RP 13B-2:2005, *Recommended practice for field testing of oil-based drilling fluids*.

As with any laboratory procedure requiring the use of potentially hazardous chemicals and equipment, the user is expected to have received proper training and knowledge in the use and disposal of these potentially hazardous materials. The user is responsible for compliance with all applicable local, regional and national requirements for worker and local health, safety and environmental liability.

In this part of ISO 10414, quantities expressed in the International System (SI) of units are also, where practical, expressed in United States Customary (USC) units in parentheses for information. The units do not necessarily represent a direct conversion of SI units to USC units, or USC units to SI units. Consideration has been given to the precision of the instrument making the measurement. For example, thermometers are typically marked in one degree increments, thus temperature values have been rounded to the nearest degree.

Calibrating an instrument refers to ensuring the accuracy of the measurement. Accuracy is the degree of conformity of a measurement of a quantity to its actual or true value. Accuracy is related to precision, or reproducibility, of a measurement. Precision is the degree to which further measurements or calculations will show the same or similar results. Precision is characterized in terms of the standard deviation of the measurement. The results of calculations or a measurement can be accurate but not precise, precise but not accurate, neither accurate nor precise, or both accurate and precise. A result is valid if it is both accurate and precise.

Petroleum and natural gas industries — Field testing of drilling fluids —

Part 2: Oil-based fluids

1 Scope

This part of ISO 10414 provides standard procedures for determining the following characteristics of oil-based drilling fluids:

a) drilling fluid density (mud weight);

b) viscosity and gel strength;

c) filtration;

d) oil, water and solids concentrations;

e) alkalinity, chloride concentration and calcium concentration;

f) electrical stability;

g) lime and calcium concentrations, calcium chloride and sodium chloride concentrations;

h) low-gravity solids and weighting material concentrations.

The annexes provide additional test methods or examples that can optionally be used for the determination of:

— shear strength (Annex A);

— oil and water concentrations from cuttings (Annex B);

— drilling fluid activity (Annex C);

— aniline point (Annex D);

— lime, salinity and solids concentration (Annex E);

— sampling, inspection and rejection (Annex F);

— rig-site sampling (Annex G);

— cuttings activity (Annex H);

— active sulphides (Annex I);

— calibration and verification of glassware, thermometers, viscometers, retort kit cups and drilling fluid balances (Annex J);

- permeability plugging apparatus with set-screw secured end cap (Annex K);
- permeability plugging apparatus with threaded end cap (Annex L);
- elastomer compatibility (Annex M);
- sand content of oil-based fluid (Annex N);
- identification and monitoring of weight-material sag (Annex O);
- oil-based drilling fluid test report form (Annex P).

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 10414-1:2008[1)], *Petroleum and natural gas industries — Field testing of drilling fluids — Part 1: Water-based fluids*

ISO 13501[2)], *Petroleum and natural gas industries — Drilling fluids — Processing equipment evaluation*

API RP 13D:2010, *Recommended practice on the rheology and hydraulics of oil-well drilling fluids*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
ACS reagent grade
grade of chemical meeting the purity standards specified by the American Chemical Society (ACS) and listed in the Chemical Abstracting Service (CAS)

3.2
density of water
density of 1 g/ml (8,334 lb/gal) for deionized or distilled water and 1 g/ml (8,345 lb/gal) for clean tap water

NOTE Deionized or distilled water is used for all equipment calibration. The volume of 1 kg of water is 1 l for the purposes of this part of ISO 10414, and the volume of water is numerically equivalent to the volume of the water measured in cubic centimetres or millilitres, i.e. 1 g = 1 ml.

3.3
spurt loss
volume of fluid that passes through the filtration medium before a filter cake is formed

3.4
pound
U.S. customary unit used to indicate pound-mass (weight), as opposed to pound-force (shear stress)

1) For the purposes of this part of ISO 10414, API RP 13B-1:2009, *Recommended practice for field testing water-based drilling fluids*, is equivalent.

2) For the purposes of this part of ISO 10414, API RP 13C, *Recommended practice on drilling fluids processing systems evaluation*, is equivalent.

3.5
volumic mass
dimensionless ratio of the mass of a volume of an object substance to the mass of the same volume of a reference substance, i.e. the ratio of their respective mass densities

NOTE 1 Generally speaking, the reference substance is pure water.

NOTE 2 Volumic mass is commonly known as specific gravity.

4 Symbols and abbreviated terms

4.1 Symbols

a_{DF}	measure of the chemical potential or reaction availability of drilling fluid
a_W	measure of the chemical potential or reaction availability of water solutions of standard salts
a_C	measure of the chemical potential or reaction availability of drilled cuttings
b	slope of the annular velocity and shear stress at the wall in laminar flow, as defined in O.7.2.8
B_{VSST}	amount of weight-material sag, expressed in pounds-mass per gallon[3)]
C	correction value to add to thermometer reading
$c_{Ca^{+2},DF}$	whole-drilling-fluid calcium concentration, expressed in milligrams per litre
c_{Ca^{+2},H_2O}	aqueous-phase calcium concentration per volume of pure water, expressed in milligrams per litre
$c_{CaCl_2,AQ}$	aqueous-phase calcium chloride concentration, expressed in milligrams per litre
$c_{CaCl_2,DF,A}$	whole-drilling-fluid calcium chloride concentration, expressed in milligrams per litre
$c_{CaCl_2,DF,B}$	whole-drilling-fluid calcium chloride concentration, expressed in pounds per barrel
$c_{CaCl_2,DF,C}$	whole-drilling-fluid calcium chloride concentration, expressed in kilograms per cubic metre
$c_{Ca(OH)_2,\%}$	lime assay value, expressed as a weight fraction
$c_{Ca(OH)_2,DF,B}$	whole-drilling-fluid total lime concentration, expressed in pounds per barrel
$c_{Ca(OH)_2,DF,C}$	whole-drilling-fluid total lime concentration, expressed in kilograms per cubic metre
$c_{Ca(OH)_2,F}$	lime concentration of field lime, expressed in kilograms per cubic metre or pounds per barrel

3) Gallon as used throughout this part of ISO 10414 refers to the U.S. gallon of 3,785 4 litres.

$c_{Cl^-,DF}$	whole-drilling-fluid chloride concentration, expressed in milligrams per litre
$c_{Cl^-(CaCl_2),DF}$	whole-drilling-fluid chloride concentration as calcium chloride, expressed in milligrams per litre
$c_{Cl^-(NaCl),DF}$	whole-drilling-fluid chloride concentration from sodium chloride, expressed in milligrams per litre
$c_{NaCl,AQ}$	aqueous-phase sodium chloride concentration, expressed in milligrams per litre
$c_{LG,B}$	low-gravity solids concentration, expressed in pounds per barrel
$c_{LG,C}$	low-gravity solids concentration, expressed in kilograms per cubic metre
$c_{NaCl,DF,A}$	whole-drilling-fluid sodium chloride concentration, expressed in milligrams per litre
$c_{NaCl,DF,B}$	whole-drilling-fluid sodium chloride concentration, expressed in pounds per barrel
$c_{NaCl,DF,C}$	whole-drilling-fluid sodium chloride concentration, expressed in kilograms per cubic metre
$c_{NaCl,DF,INSOL,A}$	whole-drilling fluid insoluble sodium chloride concentration, expressed in milligrams per litre
$c_{NaCl,DF,INSOL,B}$	whole-drilling-fluid insoluble sodium chloride concentration, expressed in pounds per barrel
$c_{NaCl,DF,SOL,A}$	whole-drilling-fluid soluble sodium chloride concentration, expressed in milligrams per litre
$c_{NaCl,DF,SOL,B}$	whole-drilling-fluid soluble sodium chloride concentration, expressed in pounds per barrel
$c_{NaCl,DF,SOL,C}$	whole-drilling-fluid soluble sodium chloride concentration, expressed in kilograms per cubic metre
c_{S-2}	concentration of active sulfides, expressed in milligrams per litre
$c_{WM,B}$	weighting material concentration, expressed in pounds per barrel
$c_{WM,C}$	weighting material concentration, expressed in kilograms per cubic metre
d_1	distance from the outer wall, expressed in inches
D	outer pipe diameter or inner diameter of open hole, expressed in inches
d	inner pipe diameter, expressed in inches
D_{TVD}	true vertical depth, expressed in feet
E	pump efficiency, expressed as percentage
f	tube factor, taken from Table I.2
G'	storage modulus, expressed in Newtons per square metre
G''	loss modulus, expressed in Newtons per square metre
k_C	consistency factor, expressed in pounds-force per second

L	length of the hydraulic section, expressed in feet
L_A	length, expressed in feet
l	submerged length of shear tube, expressed in centimetres
l_A	submerged length of shear tube, expressed in inches
l_D	Dräger tube darkened length (stained length), marked in units on the tube
m_1	mass of the empty retort assembly (cup, lid and body packed with steel wool), expressed in grams
m_2	mass of the filled retort assembly (cup with sample, lid and body packed with steel wool), expressed in grams
m_3	mass of the empty, dry liquid receiver, expressed in grams
m_4	mass of the cooled liquid receiver with condensed liquids, expressed in grams
m_5	mass of the cooled retort assembly (body packed with steel wool), expressed in grams;
m_d	mass of the dried retort cuttings, expressed in grams
m_{F1}	mass of drilling fluid following shear at 100 r/min, expressed in grams
m_{F2}	mass of drilling fluid taken from Sag Shoe following shear at 100 r/min, expressed in grams
m_{F3}	mass of drilling fluid taken from Sag Shoe following shear at 600 r/min, expressed in grams
m_L	mass of the liquid condensed (oil and water), expressed in grams
m_O	mass of the oil, expressed in grams
m_S	mass of the liquid drilling fluid sample, expressed in grams
m_{st}	mass of shear tube, expressed in grams
m_{tot}	total shear mass (sum of platform and weights), expressed in grams
m_{WC}	mass of the wet cuttings, expressed in grams
m_W	mass of water, expressed in grams
P	measured pressure, expressed in pounds-gauge per square inch
ΔP	anticipated pressure increase, expressed in pounds-gauge per square inch
$\frac{\Delta P}{\Delta L_A}$	pressure gradient, expressed in pounds-gauge per square inch per foot
Q	pump rate, expressed in gallons per minute
R_1	average reading for the standard thermometer, expressed in degrees

R_2	average reading for the working thermometer, expressed in degrees
R_{600}	dial reading at 600 revolutions per minute, expressed in degrees deflection
R_{300}	dial reading at 300 revolutions per minute, expressed in degrees deflection
R_{BPU}	calculated bed pickup measurement ratio, expressed as a percentage
R_O	ratio of the volume fraction of oil to the sum of the volume fractions of oil and pure water from the retort analysis, expressed as a percentage
R_B	ratio of the volume fraction of oil to the sum of the volume fractions of oil and brine, expressed as a percentage
R_W	ratio of the volume fraction of water to the sum of the volume fractions of oil and pure water from the retort analysis, expressed as a percentage
ROC	retained oil on cuttings, expressed in grams per kilogram of cuttings (either wet or dry)
S	Sag Register
t	time, expressed in minutes
V_1	spurt loss, expressed in millilitres
$V_{7,5}$	filtrate volume after 7,5 min, expressed in millilitres
V_{30}	filtrate volume after 30 min, expressed in millilitres
V_A	annular volume, expressed in barrels
V_{AgNO_3}	volume of 0,282 mol/l (0,282 N) silver nitrate reagent, expressed in millilitres
V_B	base alkalinity demand
V_{EDTA}	volume of 0,1 mol/l EDTA solution, expressed in millilitres
V_F	filtrate volume
$V_{H_2SO_4}$	volume of 0,05 mol/l (0,1 N) sulfuric acid, expressed in millilitres
V_K	whole-drilling-fluid alkalinity, expressed in millilitres of 0,05 mol/l sulfuric acid
V_M	receiver volume at specific mark, expressed in millilitres
V_{NaOH}	volume of 0,1 mol/l (0,1 N) NaOH, expressed in millilitres
V_O	volume of oil, expressed in millilitres
V_{PPT}	volume of filtrate from PPT, expressed in millilitres
V_R	total volume of condensed liquids (oil and water), expressed in millilitres
V_{RC}	volume of retort cup, expressed in millilitres

V_S	drilling fluid sample volume, expressed in millilitres;
V_W	water volume, expressed in millilitres, or water mass, expressed in grams (1 ml = 1 g) (see 3.2)
Δv_a	change in annular velocity, expressed in feet per minute
v_a	annular velocity, expressed in feet per minute.
v_f	static filtration rate (velocity of flow), expressed in millilitres per minute$^{1/2}$
w_{CaCl_2}	aqueous-phase mass fraction of calcium chloride, expressed as a percentage of the total aqueous-phase mass
$w_{CaCl_2,SAT}$	aqueous-phase mass fraction of calcium chloride of a super-saturated fluid, expressed as a percentage of the total aqueous-phase mass
w_{NaCl}	aqueous-phase mass fraction of sodium chloride, expressed as a percentage of the total aqueous phase mass
$w_{NaCl,MAX}$	maximum aqueous-phase mass fraction of soluble sodium chloride that can exist for a given mass fraction of calcium chloride, expressed as a percentage of the total aqueous phase mass
$w_{NaCl,MAX-C}$	recalculated maximum aqueous-phase mass fraction of soluble sodium chloride that can exist for a given mass fraction of calcium chloride, expressed as a percentage of the total aqueous phase mass
Y_{PA}	yield point, expressed in pascals
Y_{PB}	yield point, expressed in pounds per one hundred square feet, often expressed as YP
β_{10m}	gel strength at 10 min, expressed in pounds per one hundred square feet
β_{10s}	gel strength at 10 s, expressed in pounds per one hundred square feet
$\Gamma_{DFG,A}$	drilling fluid gradient, expressed in kilopascals per metre
$\Gamma_{DFG,B}$	drilling fluid gradient, expressed in pounds per square inch per foot
γ_A	shear strength of the drilling fluid, expressed in pounds per square inch per foot
γ_B	shear strength of the drilling fluid, expressed in pascals
γ_i	fluid shear rate, expressed in reciprocal seconds
η	drillpipe rotation, expressed in revolutions per minute
η_{AV}	apparent viscosity, expressed in millipascal seconds (centipoises)
η_{PV}	plastic viscosity, expressed in millipascal seconds (centipoises)
φ_B	volume fraction of brine, expressed as a percentage of the whole drilling fluid

φ_D	corrected volume fraction of solids, expressed as a percentage of the whole drilling fluid
φ_d	volume fraction of dried retort solids, expressed as a percentage of the total sample volume
φ_{LG}	volume fraction of the low-gravity solids, expressed as a percentage of the total suspended solids
φ_O	volume fraction of oil, expressed as a percentage of the whole drilling fluid
φ_W	volume fraction of pure water, expressed as a percentage of the whole drilling fluid
φ_{WM}	volume fraction of the weighting material solids, expressed as a percentage of the total suspended solids
ρ	drilling fluid density, expressed in pounds per gallon
ρ_B	aqueous-phase density, expressed in grams per millilitre
ρ_C	drilling fluid density, expressed in kilograms per cubic metre
ρ_{B1}	drilling fluid density, expressed in pounds per gallon
ρ_{B2}	drilling fluid density, expressed in pounds per cubic foot
$\overline{\rho_d}$	average density (volumic mass) of the suspended solids.
$\rho_{ECD\text{-}hyd}$	pressure drop and extra density effects of drilled cuttings
$\rho_{ECD\text{-}tot}$	total predicted equivalent circulating density
$\Delta\rho_{ECD\text{-}rot}$	change in pressure due to rotation
ρ_{LG}	density of the low-gravity solids, expressed in grams per millilitre
ρ_{max}	maximum recorded drilling fluid density, expressed in pounds per gallon
ρ_{nom}	nominal drilling fluid density, expressed in pounds per gallon
ρ_O	density of the oil being used, expressed in grams per millilitre
ρ_S	drilling fluid density, expressed in grams per millilitre
ρ_w	water density, expressed in grams per millilitre, at the test temperature (see Table J.1)
ρ_{WM}	density of the weighting material solids, expressed in grams per millilitre
τ_W	wall shear stress, expressed in pounds-force per hundred square feet
τ_Y	drilling fluid yield stress, expressed in pounds-force per hundred square feet

4.2 Abbreviated terms

ACS	American Chemical Society
API	American Petroleum Institute
ASTM	American Society of Testing Materials
AV	apparent viscosity
CAS	Chemical Abstracting Services
ECD	equivalent circulating density [expressed in kilograms per cubic metre (pounds per gallon)]
EDTA	sodium salt of ethylenediaminetetraacetic acid dihydrate
ERD	extended reach drilling
ES	electrical stability
ESD	equivalent static density [expressed in kilograms per cubic metre (pounds per gallon)]
HTHP	high temperature, high pressure
OCMA	Oil Company Materials Association
OBR	oil-to-brine ratio
OWR	oil-to-water ratio
PNP	propylene glycol normal-propyl ether
PPA	permeability plugging apparatus
PPT	permeability plugging test
PTFE	polytetrafluoroethylene (e.g. Teflon®)
PV	plastic viscosity
PVT	pressure, volume and temperature relationship
SI	International System of units
TC	to contain
TD	to deliver
TVD	true vertical depth [expressed in metres (feet)]
USC	United States Customary units
VSST	Viscometer Sag Shoe Test
YP	yield point