INTERNATIONAL STANDARD

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Second edition
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Petroleum and natural gas industries — Drilling fluids — Processing equipment evaluation

Industries du pétrole et du gaz naturel — Fluides de forage — Évaluation des équipements de traitement

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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 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 13501 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for 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 13501:2005), which has been technically revised.

The main changes compared with the first edition are as follows:

— Clause 11 specifies a different labelling requirement for shale shaker screens that are permanently attached to the screen, and also covers the marking of shipping containers for shale shaker screens;

— Annex B describes a standard procedure for the quick assessment of a solids control screen sizing, which can be used in the field or laboratory for identification of an unknown screen approximate size range.

NOTE The procedure described in Annex B is provided for information only and does not replace or supplement the normative testing in accordance with Clauses 9, 10 and 11, nor is it intended for the operating comparison or ranking of similar types of individual pieces of equipment.

Introduction

This International Standard is based on API RP 13C, 3rd edition, December 2004 (for drilling fluid processing equipment) and shale shaker screen API RP 13E, 3rd edition, May 1993 (for shale shaker screens).

The purpose of this International Standard is to provide a method of assessing the performance of solids control equipment systems in the field. It includes procedures for evaluation of shale shakers, centrifugal pumps, degassers, hydrocyclones, mud cleaners and centrifuges, as well as an entire system evaluation. Shale shaker screen labelling and separation potential of shale shaker screens have been addressed within this International Standard.

This International Standard covers equipment which is commonly used in petroleum and natural gas drilling fluids processing. This equipment can be purchased or rented from multiple sources, and is available worldwide. No single-source or limited-source equipment is included, either by inference or reference.

In this International Standard, quantities expressed in the International System (SI) of units are also, where practical, expressed in United States Customary (USC) units for information.

NOTE The units do not necessarily represent a direct conversion of SI units to USC units, or of 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.

This International Standard refers to assuring the accuracy of the measurement. Accuracy is the degree of conformity of a measurement of a quantity to the 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 result of calculation or a measurement can be accurate, but not precise, precise but not accurate, neither or both. A result is valid if it is both accurate and precise.

Users of this International Standard should be aware that further or differing requirements may be needed for individual applications. This International Standard is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this International Standard and provide details.

Petroleum and natural gas industries — Drilling fluids — Processing equipment evaluation

1 Scope

This International Standard specifies a standard procedure for assessing and modifying the performance of solids control equipment systems commonly used in the field in petroleum and natural gas drilling fluids processing.

The procedure described in this International Standard is not intended for the comparison of similar types of individual pieces of equipment.

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 3310-1[1)], *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*

ISO 10414-1[2)], *Petroleum and natural gas industries — Field testing of drilling fluids — Part 1: Water-based fluids*

ISO 10414-2[3)], *Petroleum and natural gas industries — Field testing of drilling fluids — Part 2: Oil-based fluids*

ANSI/AWWA C700, *Cold-Water Meters — Displacement Type, Bronze Main Case*

API, *Manual of Petroleum Measurement Standards*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

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

3.1.1
addition section
compartment(s) in the surface drilling fluid system, between the removal section and the suction section, which provides (a) well-agitated compartment(s) for the addition of commercial products such as chemicals, necessary solids and liquids

1) For the purposes of this International Standard, ASTM E11-95 is equivalent to ISO 3310-1.

2) For the purposes of this International Standard, API RP 13B-1 is equivalent to ISO 10414-1.

3) For the purposes of this International Standard, API RP 13B-2 is equivalent to ISO 10414-2.

3.1.2
agitator
mechanical stirrer
mechanically driven mixer that stirs the drilling fluid, by turning an impeller near the bottom of a mud compartment to blend additives, suspend solids and maintain a uniform consistency of the drilling fluid

3.1.3
aperture
⟨screen cloth⟩ opening between the wires in a screen cloth

3.1.4
aperture
⟨screen surface⟩ opening in a screen surface

3.1.5
apex
opening at lower end of a hydrocyclone

3.1.6
API sand
⟨physical description⟩ particles in a drilling fluid that are too large to pass through a 74 µm sieve (API 200 screen)

NOTE 1 Its amount is expressed as a volume fraction (percent) of drilling fluid.

NOTE 2 Particle size is a descriptive term; the particles can be shale, limestone, wood, gold or any other material.

3.1.7
API screen number
number in an API system used to designate the D100 separation range of a mesh screen cloth

NOTE 1 Both mesh and mesh count are obsolete terms, and have been replaced by the API screen number.

NOTE 2 The term “mesh” was formerly used to refer to the number of openings (and fraction thereof) per linear inch in a screen, counted in both directions from the centre of a wire.

NOTE 3 The term “mesh count” was formerly used to describe the fineness of a square or rectangular mesh screen cloth, e.g. a mesh count such as 30 × 30 (or, often, 30 mesh) indicates a square mesh, while a designation such as 70 × 30 mesh indicates a rectangular mesh.

NOTE 4 See 9.6 for further information.

3.1.8
backing plate
support plate attached to the back of screen cloth(s)

3.1.9
baffle
plate or obstruction built into a compartment to change the direction of fluid flow

3.1.10
barite
baryte
natural barium sulfate ($BaSO_4$) used for increasing the density of drilling fluids

NOTE The standard international requirement is for a minimum specific gravity of 4,20 or 4,10 for two grades of barite, but there is no specification that the material must be barium sulfate. Commercial ISO 13500 barite can be produced from a single ore or a blend of ores, and can be a straight-mined product or processed by flotation methods. It can contain accessory minerals other than barium sulfate ($BaSO_4$). Because of mineral impurities, commercial barite can vary in colour from off-white to grey to red or brown. Common accessory minerals are silicates such as quartz and chert, carbonate compounds such as siderite and dolomite, and metallic oxide and sulfide compounds.

3.1.11
blinding
reduction of open area in a screening surface caused by coating or plugging

3.1.12
bonding material
material used to secure screen cloth to a backing plate or support screen

3.1.13
capture
mass fraction of incoming suspended solids that are conveyed to the reject stream

NOTE See Clause 6.

3.1.14
centrifugal pump
machine for moving fluid by spinning it using a rotating impeller in a casing with a central inlet and a tangential outlet

NOTE The path of the fluid is an increasing spiral from the inlet at the centre to the outlet, tangent to the impeller annulus. In the annular space between the impeller vane tips and the casing wall, the fluid velocity is roughly the same as that of the impeller vane tips. Useful work is produced by the pump when some of the spinning fluid flows out of the casing tangential outlet into the pipe system. Power from the motor is used to accelerate the fluid entering the inlet up to the speed of the fluid in the annulus. Some of the motor power is expended as friction of the fluid in the casing and impeller.

3.1.15
centrifuge
device, rotated by an external force, for the purpose of separating materials of various masses (depending upon specific gravity and particle sizes) from a slurry to which the rotation is imparted primarily by the rotating containing walls

NOTE In a weighted drilling fluid, a centrifuge is usually used to eliminate colloidal solids.

3.1.16
check section
suction section
last active section in the surface system which provides a location for rig pump and mud hopper suction, and ideally is large enough to check and adjust drilling fluid properties before the drilling fluid is pumped downhole

3.1.17
clay mineral
soft, variously coloured earth, commonly hydrous silicate of alumina

NOTE Clay minerals are essentially insoluble in water, but disperse under hydration, grinding, heating or velocity effects. Particle sizes of clay mineral can vary from sub-micrometre to larger than 100 µm.

3.1.18
clay particle
colloidal particles of clay mineral having less than 2 µm equivalent spherical diameter

NOTE See **colloidal solid** (3.1.21).

3.1.19
coating
⟨substance⟩ material adhering to a surface to change the properties of the surface

NOTE See **blinding** (3.1.11).

3.1.20
coating
⟨physical process⟩ procedure by which material forms a film that covers the apertures of the screening surface

NOTE See **blinding** (3.1.11).

3.1.21
colloidal solid
particle of diameter less than 2 µm

NOTE This term is commonly used as a synonym for clay particle size.

3.1.22
conductance
permeability per unit thickness of a static (not in motion) shale shaker screen

NOTE Conductance is expressed in units of kilodarcies per millimetre[4)].

3.1.23
cuttings
formation pieces dislodged by the drill bit and brought to the surface in the drilling fluid

NOTE Field practice is to refer to all solids removed by the shaker screen as “cuttings”, although some can be sloughed material.

3.1.24
D100 separation
particle size, expressed in micrometres, determined by plotting the percentage of aluminium oxide sample separated by the test screen on the plot of cumulative mass fraction (expressed as a percentage) retained versus US sieve opening (expressed in micrometres) for the sieve analysis of the aluminium oxide test sample

NOTE 100 % of the particles larger than the D100 separation are retained by the test screen.

3.1.25
decanting centrifuge
centrifuge that removes solids from a feed slurry by rotating the liquid in cylindrical bowl at high speed and discharges the larger particles as a damp underflow

NOTE Colloidal solids are discharged with the liquid overflow or light slurry. The decanting centrifuge has an internal auger that moves solids that have settled to the bowl walls out of a pool of liquid and to the underflow.

3.1.26
density
mass divided by volume

NOTE 1 In SI units, density is expressed in kilograms per cubic metre; in USC units, it is expressed as pounds per gallon or pounds per cubic foot.

NOTE 2 Drilling fluid density is commonly referred to as “drilling fluid weight” or “mud weight”.

3.1.27
desander
hydrocyclone with an inside diameter of at least 152 mm (6 in) that removes a high proportion of the particles with a diameter of at least 74 µm from a drilling fluid

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4) The darcy is not an SI unit, but kilodarcies per millimetre (kD/mm) is the recommended unit for this International Standard. The SI unit of permeability to fluid flow is defined as the amount of permeability that permits 1 m^3 of fluid of a viscosity of 1 Pa·s to flow through a section that is 1 m thick with a cross-section of 1 m^2 in 1 s at a pressure difference of 1 Pa. Therefore, in the SI system of units, permeability is expressed in square metres: 1 $m^2 = 1{,}013\,25 \times 10^{12}$ darcies.

3.1.28
desilter
hydrocyclone with an inside diameter of less than 152 mm (6 in)

3.1.29
dilution
method of decreasing the drilled-solids content of a slurry by addition of (a) material(s) other than drilled solids, usually a clean drilling fluid

3.1.30
dilution factor
k
ratio of the actual volume of clean drilling fluid required to maintain a targeted drilled-solids concentration to the volume of drilling fluid required to maintain the same drilled-solids fraction over the same specified interval of footage with no drilled-solids removal system

3.1.31
drilled solids
formation solids that enter the drilling fluid system, whether produced by the drill bit or from the side of the borehole

3.1.32
drilled-solids fraction
average volume fraction of drilled solids maintained in the drilling fluid over a specified interval of footage

3.1.33
drilled-solids removal system
equipment and processes used while drilling a well that remove the solids generated from the hole and carried by the drilling fluid

NOTE These processes include settling, screening, desanding, desilting, centrifuging and dumping.

3.1.34
drilled-solids removal system performance
measure of the removal of drilled solids by surface solids-control equipment

NOTE The calculation is based on a comparison of the dilution required to maintain the desired drilled-solids content with that which would have been required if none of the drilled solids were removed.

3.1.35
drilling fluid
liquid or slurry pumped down the drill string and up the annulus of a hole during the drilling operation

3.1.36
eductor
⟨fluid stream⟩ device using a fluid stream that discharges under high pressure from a jet through an annular space to create a low-pressure region

NOTE When properly arranged, it can evacuate degassed drilling fluid from a vacuum-type degasser or pull solids through a hopper.

3.1.37
eductor
⟨pressure jet⟩ device using a high-velocity jet to create a low-pressure region which draws liquid or dry material to be blended with the drilling fluid

NOTE The use of a high-velocity jet to create a low-pressure region is known as the Bernoulli principle.

3.1.38
effluent
discharge of liquid, generally a stream, after some attempt at separation or purification has been made

3.1.39
equalizer
opening for flow between compartments in a surface fluid-holding system, which allows all compartments to maintain the same fluid level

3.1.40
flow capacity
rate at which equipment, such as a shaker, can process drilling fluid and solids

NOTE It is a function of many variables, including shaker configuration, design and motion, drilling fluid rheology, solids loading, and blinding by near-size particles.

3.1.41
flow line
piping or trough which directs drilling fluid from the rotary nipple to the surface drilling fluid system

3.1.42
flow rate
volume of liquid or slurry that moves through a pipe in one unit of time

NOTE Flow rate is expressed as cubic metres per minute, gallons per minute, barrels per minute, etc.

3.1.43
foam
⟨phase system⟩ two-phase system, similar to an emulsion, in which the dispersed phase is air or gas

3.1.44
foam
⟨floating material⟩ bubbles floating on the surface of the drilling fluid

NOTE The bubbles are usually air-cut drilling fluid, but can be formation gasses.

3.1.45
gumbo
cuttings that agglomerate and form a sticky mass as they are circulated up the wellbore

3.1.46
head
height that a fluid column would reach in an open-ended pipe if the pipe were attached to the point of interest

NOTE The head at the bottom of a 300 m (1 000 ft) well is 300 m (1 000 ft), but the pressure at that point depends upon the density of the drilling fluid in the well.

3.1.47
high specific gravity solids
solids added to a drilling fluid specifically to increase drilling fluid density

NOTE Barite (specific gravity = 4,2) and haematite (specific gravity = 5,05) are the most common.

3.1.48
hook strip
hooks on the edge of a screen section of a shale shaker which accept the tension member for screen mounting

3.1.49
hopper
mud hopper
large, funnel-shaped or coned-shaped device, into which dry components are poured to mix the components uniformly with liquids or slurries that are flowing through the lower part of the cone

3.1.50
hydrocyclone
cone
cyclone
liquid-solids separation device using centrifugal force for settling

NOTE Fluid enters tangentially and spins inside the hydrocyclone. The heavier solids settle to the walls of the hydrocyclone and move downward until they are discharged at the hydrocyclone apex. The spinning fluid travels part way down the hydrocyclone and back up to exit out the top of the hydrocyclone through a vortex finder.

3.1.51
impeller
spinning disc in a centrifugal pump with protruding vanes, used to accelerate the fluid in the pump casing

3.1.52
manifold
length of pipe with multiple connections for collecting or distributing drilling fluid

3.1.53
Marsh funnel viscosity
funnel viscosity
viscosity measured with the instrument used to monitor drilling fluid

NOTE 1 A Marsh funnel is a tapered container with a fixed orifice at the bottom so that, when filled with 1 500 cm^3 of fresh water, 946 cm^3 (one quart) will drain in 26 s. It is used for comparison values only and not to diagnose drilling fluid problems.

NOTE 2 See ISO 10414-1 or ISO 10414-2.

NOTE 3 For the purposes of this International Standard, API RP 13B-1 is equivalent to ISO 10414-1 and API RP 13B-2 is equivalent to ISO 10414-2.

3.1.54
mud
slurry of insoluble and soluble solids in either water or a synthetic or oil continuous-phase fluid

NOTE See **drilling fluid** (3.1.35).

3.1.55
mud balance
beam-type balance used in determining drilling fluid density

NOTE 1 See ISO 10414-1 or ISO 10414-2.

NOTE 2 For the purposes of this International Standard, API RP 13B-1 is equivalent to ISO 10414-1 and API RP 13B-2 is equivalent to ISO 10414-2.

3.1.56
mud cleaner
combination of hydrocyclones and screens in series with the underflow of the hydrocyclones

NOTE The hydrocyclone overflow returns to the drilling fluid, while the underflow of the hydrocyclones is processed through a vibrating screen. The screen is usually of size API 150 or finer. The screen solids discharge is discarded while the liquid and solids passing through the screen are returned to the drilling fluid.

3.1.57
mud compartment
subdivision of the removal, addition or check/suction sections of a surface system

3.1.58
mud gun
submerged nozzle used to stir drilling fluid with a high-velocity stream

3.1.59
near-size particle
particle whose size is close to the size of the openings in the screen through which its passage is under evaluation

3.1.60
oil-based drilling fluid
drilling fluid in which the continuous phase is not miscible with water, and water or brine is the dispersed phase

NOTE Oil-based drilling fluids are usually referred to as non-aqueous drilling fluids, or NAF.

3.1.61
overflow
centrate
discharge stream from a centrifugal separation that contains a higher percentage of liquids than the feed does

3.1.62
particle
discrete unit of solid material that consists of a single grain, or of any number of grains stuck together

3.1.63
particle size distribution
mass or net volume classification of solid particles into each of the various size ranges, as a percentage of the total solids of all sizes in a fluid sample

3.1.64
plastic viscosity
measure of the high-shear-rate viscosity, which depends upon the number, shape and size of solids and the viscosity of the liquid phase

NOTE 1 Plastic viscosity is calculated by subtracting the 300 r/min concentric cylinder viscometer reading from the 600 r/min concentric cylinder viscometer reading.

NOTE 2 See ISO 10414-1 or ISO 10414-2.

NOTE 3 For the purposes of this International Standard, API RP 13B-1 is equivalent to ISO 10414-1 and API RP 13B-2 is equivalent to ISO 10414-2.

NOTE 4 In SI units, plastic viscosity is expressed in pascal seconds; in USC units, plastic viscosity is expressed in centipoises.

3.1.65
plugging
wedging or jamming of openings in a screening surface by near-size particles, which prevents the passage of undersize particles and leads to the **blinding** (3.1.11) of the screen

3.1.66
possum belly
compartment or back tank on a shale shaker, into which the flow line discharges and from which drilling fluid is either fed to the screens or is bypassed, if necessary

3.1.67
removal section
first section in the surface drilling fluid system, consisting of a series of compartments to remove gas and undesirable solids

3.1.68
retort
instrument used to distil oil, water and other volatile material in a drilling fluid

NOTE 1 The amount of volatile fluid is used to determine oil, water and total solids contents as volume fraction percent, expressed as a percentage.

NOTE 2 See ISO 10414-1 or ISO 10414-2.

NOTE 3 For the purposes of this International Standard, API RP 13B-1 is equivalent to ISO 10414-1 and API RP 13B-2 is equivalent to ISO 10414-2.

3.1.69
sand trap
first compartment in a surface system, and the only compartment that is unstirred or unagitated, which is intended as a settling compartment

3.1.70
screen cloth
type of screening surface woven in square, rectangular or slotted openings

3.1.71
screening
mechanical process that results in a division of particles on the basis of size, based on their acceptance or rejection by a screening surface

3.1.72
shale shaker
mechanical device that separates cuttings and large solids from a drilling fluid

NOTE The separation methods can include vibrating screens, rotating cylindrical screens, etc.

3.1.73
sieve
laboratory screen with wire-mesh or electronically-punched holes of known dimensions

3.1.74
sieve analysis
classification by mass of solid particles passing through or retained on a sequence of screens with decreasing aperture sizes

NOTE Sieve analysis can be carried out by wet or dry methods.

3.1.75
slug tank
small compartment, normally adjacent to the suction compartment, used to mix special fluids to pump downhole

NOTE Slug tanks are most commonly used to prepare a small volume of weighted drilling fluid before a drillstring trip out of the borehole.

3.1.76
suction compartment
area of the check/suction section that supplies drilling fluid to the suction of the drilling fluid pumps

NOTE In general terms, a suction compartment is any compartment from which a pump removes fluid.