

# ISO 10416:2008-06 (E)

## Petroleum and natural gas industries - Drilling fluids - Laboratory testing

---

<b>Contents</b>		<b>Page</b>
Foreword .....		vii
Introduction .....		viii
1	Scope .....	1
2	Normative references .....	1
3	Terms and definitions .....	2
4	Symbols and abbreviations .....	3
5	Barite .....	6
5.1	Principle .....	6
5.2	Reagents and apparatus .....	6
5.3	Sampling .....	7
5.4	Calculation of moisture content .....	7
5.5	Sieve analysis .....	7
5.6	Sedimentation analysis .....	8
6	Barite performance .....	12
6.1	Principle .....	12
6.2	Reagents and apparatus .....	12
6.3	Base drilling fluid preparation .....	13
6.4	Rheology test .....	13
6.5	Calculation .....	14
7	Abrasiveness of weighting materials .....	14
7.1	Principle .....	14
7.2	Reagents and apparatus .....	15
7.3	Determination of abrasion .....	15
8	Mercury in drilling fluid barite .....	17
8.1	Principle .....	17
8.2	Reagents and apparatus .....	17
8.3	Preparation of standards .....	19
8.4	Sample digestion .....	19
8.5	Check for recovery of Hg during digestion .....	20
8.6	Analysis of standards and samples .....	20
8.7	Calculation .....	20
9	Cadmium and lead in drilling fluid barite .....	21
9.1	Principle .....	21
9.2	Reagents and apparatus .....	21
9.3	Preparation of combined cadmium and lead standards .....	22
9.4	Sample digestion .....	22
9.5	Analysis of standards and samples .....	22
9.6	Calculation .....	23
10	Arsenic in drilling fluid barite .....	23
10.1	Principle .....	23
10.2	Reagents and apparatus .....	24

10.3	Preparation of standards .....	25
10.4	Sample digestion .....	25
10.5	Analysis of standards and samples .....	26
10.6	Calculation .....	26
11	Bridging materials for regaining circulation .....	26
11.1	Principle .....	26
11.2	Apparatus .....	27
11.3	Preparation of test drilling fluid .....	27
11.4	Static slot test .....	27
11.5	Dynamic slot test .....	28
11.6	Static marble bed test .....	28
11.7	Dynamic marble bed test .....	28
11.8	Static ball bearings (BB shot) bed test .....	29
11.9	Dynamic ball bearings (BB shot) bed test .....	29
12	Filtration-control agents .....	29
12.1	Principle .....	29
12.2	Reagents and apparatus .....	29
12.3	General instructions for preparation of base drilling fluids .....	31
12.4	Salt-saturated drilling fluid .....	31
12.5	High-hardness, salt-saturated drilling fluid .....	32
12.6	10 % potassium chloride (KCl) drilling fluid .....	32
12.7	Pre-hydrated bentonite slurry .....	33
12.8	Modified seawater drilling fluid .....	33
12.9	Low-salinity drilling fluid .....	33
12.10	Lime-treated drilling fluid .....	34
12.11	Low solids, non-dispersed drilling fluid .....	34
12.12	Freshwater lignosulfonate drilling fluid .....	35
12.13	Initial performance test .....	35
12.14	Performance after heat ageing .....	36
13	Methylene blue test for drilled solids and commercial bentonite .....	36
13.1	Methylene blue capacity of drill solids .....	36
13.2	Methylene blue capacity of commercial bentonite .....	39
13.3	Solids content .....	40
14	Deflocculation test for thinner evaluation .....	41
14.1	Principle .....	41
14.2	Reagents and apparatus .....	42
14.3	Procedure for moisture content .....	43
14.4	Calculation of moisture content .....	43
14.5	Preparation of drilling fluid base .....	43
14.6	Calculation .....	44
14.7	Determination of rheological properties .....	44
14.8	Calculation of thinner efficiency .....	46
15	Testing base oils used in drilling fluids .....	46
15.1	General .....	46
15.2	Reagents and apparatus .....	46
15.3	Density, relative density (specific gravity), or API gravity-hydrometer method (see ISO 3675) .....	46
15.4	Density and relative density of liquids using a digital density meter (see ASTM D 4052) ...	47
15.5	Kinematic viscosity of transparent and opaque oils -- Calibrated capillary tube method (see ISO 3104) .....	47
15.6	Distillation (see ISO 3405) .....	47
15.7	Aniline point and mixed aniline point (see ISO 2977:1997) .....	48
15.8	Pour point (see ISO 3016) .....	48
15.9	Flash point by Pensky-Martens closed tester (see ISO 2719) .....	49
15.10	Aromatics content (see IP 391 or ASTM D 5186) .....	49
16	Potassium ion content -- Ion-selective electrode method .....	50
16.1	Principle .....	50
16.2	Reagents and apparatus .....	50
16.3	Preparation of electrodes .....	51
16.4	Operational check of electrode system .....	51
16.5	Measurements using a meter with direct concentration readout capability .....	52

16.6	Measurements with instruments that provide either a digital or an analogue readout in millivolts .....	52
17	Calcium ion content -- Ion-selective electrode method .....	53
17.1	Principle .....	53
17.2	Reagents and apparatus .....	53
17.3	Preparation of electrodes .....	54
17.4	Operational check of electrode system .....	55
17.5	Measurements using a meter with direct concentration readout capability .....	55
17.6	Measurements with instruments that provide either a digital or an analogue readout in millivolts .....	55
18	Sodium ion content -- Ion-selective electrode method .....	56
18.1	Principle .....	56
18.2	Reagents and apparatus .....	57
18.3	Preparation and operational check of the electrode system .....	57
18.4	Measurements using a meter with a direct concentration-readout capability .....	58
18.5	Measurements using a meter with readout in millivolts .....	58
19	Density of solids -- Stereopycnometer method .....	59
19.1	Principle .....	59
19.2	Apparatus .....	59
19.3	Procedure -- Stereopycnometer method .....	59
19.4	Calculation -- Stereopycnometer method .....	60
20	Density of solids -- Air comparison pycnometer method .....	61
20.1	Principle .....	61
20.2	Apparatus .....	61
20.3	Procedure -- Air comparison pycnometer method .....	61
20.4	Calculation -- Air comparison pycnometer method .....	61
21	Ageing of water-based drilling fluids .....	62
21.1	Principle .....	62
21.2	Practices common to preparation, handling and testing over all temperature ranges .....	62
21.3	Drilling fluid sample preparation and ageing at ambient temperature .....	63
21.4	Drilling fluid ageing at moderate temperatures [ambient to 65 °C (150 °F)] .....	64
21.5	Drilling fluid ageing at substantially elevated temperatures [over 65 °C (150 °F)] .....	66
21.6	Inertness and chemical compatibility in high-temperature ageing cells .....	68
21.7	Obtaining supplies and services for the ageing of drilling fluid samples .....	69
22	Ageing of oil-based drilling fluids .....	69
22.1	Principle .....	69
22.2	Apparatus .....	70
22.3	Practices common to preparation, handling and testing over all temperature ranges .....	71
22.4	Drilling fluid ageing at ambient temperatures .....	72
22.5	Drilling fluid ageing at moderate temperatures [ambient to 65 °C (150 °F)] .....	73
22.6	Drilling fluid ageing at substantially elevated temperatures [over 65 °C (150 °F)] .....	74
22.7	Inertness and chemical compatibility in high-temperature ageing cells .....	75
22.8	Obtaining supplies and services for the ageing of drilling fluid samples .....	76
23	Shale-particle disintegration test by hot rolling .....	76
23.1	Principle .....	76
23.2	Reagents and apparatus .....	77
23.3	Procedure .....	77
23.4	Calculation .....	78
24	Drilling fluid materials -- High-viscosity polyanionic cellulose (PAC-HV) (regular) .....	79
24.1	Principle .....	79
24.2	Determination of moisture content .....	79
24.3	Procedures with test fluid containing PAC-HV .....	80
25	Drilling fluid materials -- Low-viscosity polyanionic cellulose (PAC-LV) .....	82
25.1	Principle .....	82
25.2	Determination of moisture content .....	83
25.3	Procedures with test fluid containing PAC-LV .....	83
26	Preparation and evaluation of invert-emulsion drilling fluids .....	86
26.1	Principle .....	86
26.2	Reagents and apparatus .....	86
26.3	Mixing of the initial drilling fluid .....	87
26.4	Testing the properties of the initial drilling fluid .....	88

26.5	Preparation of the sample contaminated by seawater .....	88
26.6	Preparation of the sample contaminated by base evaluation clay .....	89
26.7	Preparation of the sample contaminated by mixed-salt brine .....	89
26.8	Procedure for hot-rolling .....	89
26.9	Procedure for static ageing .....	89
26.10	Procedure for testing after heat ageing .....	90
27	High-temperature/high-pressure filtration testing of drilling fluids using the permeability plugging apparatus and cells with set-screw-secured end caps .....	90
27.1	Principle .....	90
27.2	Safety considerations .....	90
27.3	Apparatus -- Permeability-plugging apparatus (PPA) with set-screw-secured end caps ....	92
27.4	Procedure for high-temperature/high-pressure (HTHP) filtration .....	94
27.5	Test conclusion and disassembly .....	97
27.6	Data reporting .....	99
28	High-temperature/high-pressure filtration testing of drilling fluids using the permeability-plugging apparatus and cells with threaded end caps .....	100
28.1	Principle .....	100
28.2	Safety considerations .....	100
28.3	Apparatus -- Permeability-plugging apparatus (PPA) with threaded end caps .....	102
28.4	Procedure for high-temperature/high-pressure (HTHP) filtration .....	104
28.5	Test conclusion and disassembly .....	106
28.6	Data reporting .....	108
Bibliography .....		109