Reservoir Drill-in and Completion Fluids

Minimise risk
Increase efficiency
Maximise productivity

Sinomine
Specialty Fluids

Your best reservoir investment

Maximise reservoir productivity with our drill-in and completion fluids made from cesium formate brine in densities of 1.57 to 2.30 g/cm^3 (13.1 to 19.2 lb/gal). They're ideal for optimising and simplifying challenging drilling and completion operations having efficiently delivered highly productive wells for 25 years without any well control incidents at temperatures as high as 235°C (455°F) and pressures up to 1,126 bar (16,331 psi).

Low-solids, non-damaging drill-in and completion fluids made from cesium formate brine

- Maximise productivity
- Minimise operational risk
- Superior well control
- Cut risk of future interventions
- Minimise formation and completion damage
- Save time and cost
- Safest high-density brine
- Gain better reservoir definition
- Corrosion protection
- Durable and stable at high temperatures
- Biostatic at high concentrations
- No need for stimulation

- Drill-in fluid
- Screen-running fluid
- Gravel-pack fluid
- Perforation pills
- Fluid-loss system

Our drill-in and completion fluids are made from high-density, solids-free cesium formate brine.

Effective drill-in fluids

Our drill-in and completion fluids made from non-damaging, low-solids cesium formate brine are ideal for reservoir drill-in operations with minimal risk of formation damage. The extremely low equivalent circulating densities (ECDs) make it ideally suited for wells with narrow windows between pore pressure and fracture gradient. It has helped simplify operations, protect assets and optimise production in numerous drill-in applications for leading operators such as Equinor, bp, Petrobras, Chevron, Shell and Total. Those operators that use it both for drill-in and completion operations see the largest efficiency gains, including elimination of cleanup time.

Case Screen running

Statoil Tune, North Sea

Four gas/condensate wells were drilled horizontally using a 1.65 g/cm^3 (13.8 lb/gal) cesium/potassium formate drilling fluid with 300 µm screens installed in the same fluid. Clear cesium/potassium formate brine was used in upper completions. The wells were suspended for six to twelve months before the upper completion was installed and the wells put on production with no filter-cake removal or stimulation treatments required. Good well cleanup with zero skin was reported. SPE 174217.

Ideal for sandface completions

You would be right to expect the best from our completion fluids made from solids-free, high-density cesium formate brine for sandface completions. Successful in over 450 applications worldwide, our brine-based fluids have time and again optimised operations in harsh environments. A recent independent study by well consultancy Ridge AS concludes that formate fluids outperform other fluids to deliver significant rig-time savings for both openhole and cased and perforated completions by enabling more time-efficient solutions, while reducing well control and environmental risk.

Non-damaging gravel-pack fluid

With our completion fluids made from cesium formate brine, your formation is protected from damage and hydrocarbon flow is assured. The clean, non-damaging nature of cesium formate brine makes it compatible with the formation and its natural high density is ideal for carrying gravel and providing hydrostatic support. If a viscous gravel-pack fluid is required, cesium formate brine can easily be viscosified with xanthan to provide an effective solution.

Run screens solids free

No weighting agents mean no risk of screen blocking, making completion fluids made with high-density cesium formate brine ideal for running screens. Furthermore, buffered cesium formate brine is highly compatible with downhole metals, negating the need for corrosion inhibitors.

The clean way to perforate

Clean, non-damaging completion fluids made from cesium formate brine are perfectly suited for challenging perforating operations. Field proven at high temperatures and pressures, cesium formate brine delivers successful perforations with maximum well control and minimal losses without compromising production. Well consultancy Ridge AS has shown that significant rig time is saved and risk eliminated by perforating on drill pipe in overbalance with cesium formate fluids compared to underbalanced perforating on coiled tubing or wireline[1].

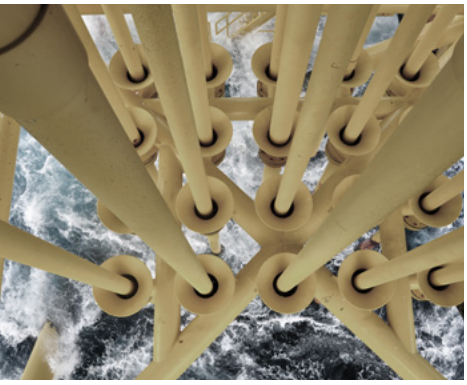
Safe long-term suspensions

When traditional solids-laden well construction fluids are left in an open hole for months or years, there is risk of formation damage, screen-plugging or hard-to-remove filter cakes. Low-solids, non-damaging formate fluids are safely left in contact with the reservoir for extended time periods. Our fluid is field proven in numerous suspensions the world over at temperatures up to 235°C (455°F), including suspensions of 15 months' duration, with no adverse effects on downhole metals.

Well construction operations using our drill-in and completion fluids are safer and more effective due to the solids-free nature of cesium formate brine.

1) Ridge AS (2015). Effect of formate fluids on rig time in North Sea HPHT and non-HPHT operations.

Drill-in and completion fluids give greater benefits



Operators see the greatest performance gains from using our drill-in and completion fluids for both drilling and completing.

Case Completion

Statoil Kvitebjørn, North Sea

Kvitebjørn is an HPHT gas/condensate field with temperature of 155°C (311°F) and pressure of 81 MPa (11,700 psi). Fourteen HPHT reservoir sections have been successfully drilled and twelve completed with cesium/potassium formate brine in the Kvitebjørn field since 2004, with one well completed in a record time of 12.7 days. Per Cato Berg, Lead Drilling Engineer for Kvitebjørn, says: "Supported by our tests and data, we feel that cesium formate gives the best productivity for the wells."

Maximise well production. Minimise formation damage risk

With cesium formate brine's unreactive nature and natural density to 2.30 g/cm^3 (19.2 lb/gal), solids content of drill-in fluids is minimised and the likelihood of delivering highly productive wells with no formation or completion damage is greatly increased. Low-solids fluids with good fluid-loss control can also be formulated with biodegradable biopolymers, such as xanthan. Cesium formate brine protects these polymers to high temperatures, making them suitable for high-temperature applications where synthetic polymers would otherwise be required.

Field proven to maximise hydrocarbon flow and well durability, our extremely inhibitive fluids are engineered to contain just the right amount of correctly sized calcium carbonate bridging material with no surfactants or other formation-damaging additives. This is in stark contrast to traditional water- and oil-based drill-in fluids that need solids to increase density with ensuing risk of severe formation plugging and excessive skin from difficult-to-remove filter cakes. The result is oil and gas wells that routinely meet or exceed production performance expectations, especially for those both drilled and completed using cesium formate fluids.

Improved well control

Low-solids drilling fluids based on cesium formate brine are proven to provide superior well control over traditional solids-laden, oil-based and water-based muds. The high-density, solids-free nature of cesium formate brine eliminates the need for weighting solids, resulting in a safe fluid that facilitates fast and efficient drill-in operations. Cesium formate-based drill-in and completion fluids deliver the following benefits:

- Elimination of weighting solids mean no sag-related problems
- No solids and low gel strengths give reduced swab/surge pressures, which reduce risk of kicks, losses and destabilisation
- Low ECDs mean that wells with narrow windows between pore and fracture pressure gradient are drilled safely without using costly techniques, such as managed pressure drilling
- Early kick detection due to low solubility of reservoir gases in formate fluids
- Low risk of hydrate plugging due to cesium formate brine's hydrate-inhibiting properties
- Overbalanced completions are enabled by cesium formate brine
- Virtual elimination of gas diffusion into high-angle wells during circulation breaks
- Reliable operation of isolation valves as our fluids are made with low amounts of solids

Case Drill-in and openhole/C&P completions

Wintershall Dea Vega, North Sea

Cesium/potassium formate fluids were used to drill-in and/or complete reservoir sections in the Vega oil and gas/condensate field – the first Wintershall Dea subsea production project offshore Norway.

Alv Solheim, Managing Director for Wintershall Dea in Norway, says:
"Vega is an excellent field, giving us the long-term predictable barrels that form the backbone of our operated production". Source: wintershalldea.no

Drill-in and completion fluids based on cesium formate brine are ideal for challenging HPHT wells.

Case Gravel pack

BP Snadd North, North Sea

BP used cesium formate brine as a circulating carrier fluid in an openhole gravel-pack completion of a horizontal gas well in the subsea Snadd gas field. The well was first suspended in cesium formate brine before 1.52 g/cm³ (12.7 lb/gal) cesium formate brine cut back with water was successfully used as carrier fluid. Diluted cesium formate brine was chosen because of its low reactivity with kaolinite shale.

Superb reservoir definition

Cesium formate brines make very conductive drilling fluids that contain few solids, creating the ideal medium for high-resolution resistivity image logging. The high-quality image logs obtainable in cesium formate brine reveal sedimentary features on a sub-centimetre scale, providing geo-modelers with important information on structural dip, depositional environment and orientation of sand bodies. This detailed information allows the creation of superior reservoir models for better decision-making.

Save time by drilling and completing in the same fluid

By using versatile cesium formate brine for both drilling and completion operations, time-consuming fluid displacement between the two phases is eliminated and costs are saved.

Corrosion protection

Cesium formate brine is highly compatible with downhole metals. With its monovalent and alkaline properties, cesium formate brine buffered with carbonate/bicarbonate provides corrosion protection in harsh carbon dioxide- and hydrogen sulfide-rich environments without corrosion inhibitors, even maintaining favourable pH after large influxes of acid gas. In fact, of over 150 high-pressure, high-temperature (HPHT) applications during 25 years there have been no recorded cases of stress corrosion cracking or pitting corrosion. Furthermore, formate brines require no added biocides, which reduces costs still further.

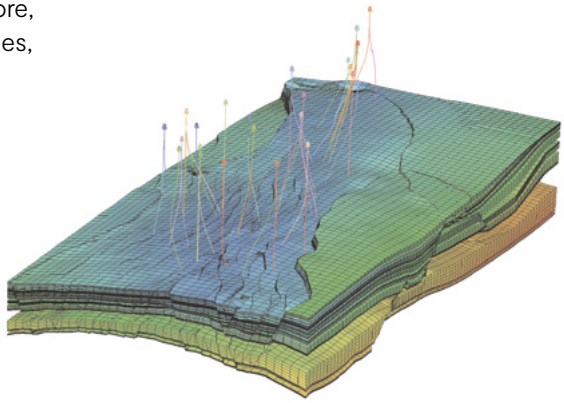
Case Perforation

Statoil Gudrun, North Sea

Gudrun is an oil and gas field in the middle of the Norwegian sector of the North Sea. The reservoir is located at a depth of 4,200 to 4,700 metres (13,780 to 15,420 feet), with reservoir pressure around 860 bar (12,473 psi) and temperature of approximately 150°C (302°F). Following drilling and completing in oil-based mud, the 4 1/2" cemented liner was successfully perforated in 1.99 g/cm³ (16.6 lb/gal) cesium formate brine with oriented TCP perforating guns shooting near vertically upwards. This is just one of many successful perforations for Statoil in the North and Norwegian Seas.

Reduce need for future interventions

With solids-free cesium formate brine the risk of formation and completion damage is minimised, which significantly cuts risk of costly workovers and interventions.



Cesium formate brine's unique properties help generate highly accurate reservoir models.

PHOTO COURTESY OF BAKER HUGHES

CHRISTINE OSBORNE PICTURES/ALAMY

Rig crews are free to work without specialist personal protective equipment when using cesium formate brine.

Safer for rig crews. Safer for the environment

High-density cesium formate brine is much safer to handle than acidic halide brines. Consequently, rig crews work effectively without the need for heavy, constrictive personal protective equipment.

Equally, cesium formate brine's low toxicity means it has minimal effect on the environment with the formate ion biodegrading entirely if discharged to the sea. It meets the demanding environmental standards set by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) in the UK, the Norwegian Environment Agency and other environmental authorities across the world.

Thermally stable and highly durable

Cesium formate brine has proved thermally stable and highly durable in over 150 HPHT wells. Our brine has been exposed for up to two years to well temperatures as high as 235°C (455°F) without any substantial changes in composition or essential properties, including density and pH.

Case Perforation

Total Kessog/Jura/ Glenelg, North Sea

A 2.14 g/cm^3 (17.8 lb/gal) cesium formate brine pill minimised losses during an overbalanced HPHT operation in this deviated appraisal well with temperature of 170°C (338°F). The well was perforated in 2.14 g/cm^3 (17.9 lb/gal) cesium formate brine with a 200-metre pill spotted above the 7" liner perforating zone.

Over the initial 19 hours post perforation, cumulative losses were only 1.43 m^3. Total also used cesium formate brine in similar operations in Jura and Glenelg with minimal fluid losses.

Case Drill-in and completion

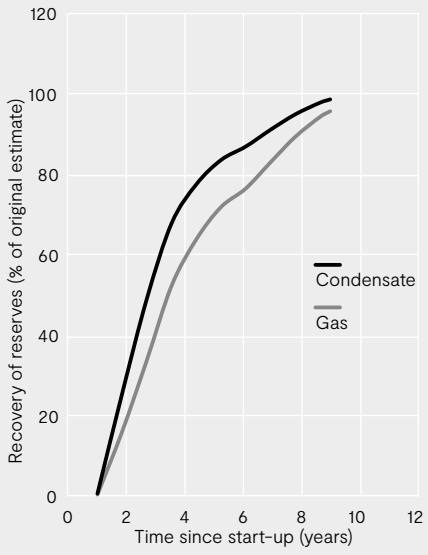
Statoil Huldra, North Sea

Cesium formate with density of 1.91 g/cm^3 (15.9 lb/gal) was used to drill and complete 8^1/$_2$" reservoir sections spread over six wells in this gas/condensate field. The wells were drilled at a 45° to 55° inclination through the reservoir and completed in openhole. Lower completions were run in the drilling fluid and upper completions in clear cesium formate brine.

Oil-based mud was used as reservoir drill-in fluid for the first Huldra well, but a severe kick was experienced while running sand screens. Following this, Statoil drilled and completed the remaining reservoir sections with cesium formate fluid claiming better well control with enhanced kick detection and production enhancement as rationale for the change.

Statoil states: "Drilling fluids based on cesium formate brine reduced risk and improved well economics on the Huldra field by: providing extremely good well control, lowering ECDs, increasing trip speed, avoiding surge and swab, reducing time for flow checks, and improving hole cleaning." SPE 74541.

Cumulative production of reserves from Huldra



Our drill-in and completion fluids made from cesium formate brine help wells produce to or beyond expectation.

No stimulation required

Ultra-thin filter cakes formed from cesium formate brine lift off very easily. Although these thin calcium carbonate filter cakes are acid soluble, no filter cake removal treatment has ever been required. Furthermore, our drill-in and completion fluids minimise risk of stimulation later in the well's life.

High-density cesium formate brine forms unique solids-free or low-solids, non-damaging drill-in and completion fluids for value-creating sandface completions and drill-in operations. Used by leading operators around the globe since 1999, this remarkable brine has helped deliver the full value of reserves with less time, risk and total cost time and again.

Case Drill-in

Petrobras El Campamento, Argentina

An 8 1/2" reservoir section was drilled with potassium formate mud in a well with temperature of 138°C (280°F). The fluid was gradually weighted up with cesium formate brine until it reached density of around 1.95 g/cm³ (16.3 lb/gal). Logging revealed a well with almost the same diameter as the bit with negligible washouts.

Case Drill-in and openhole completion

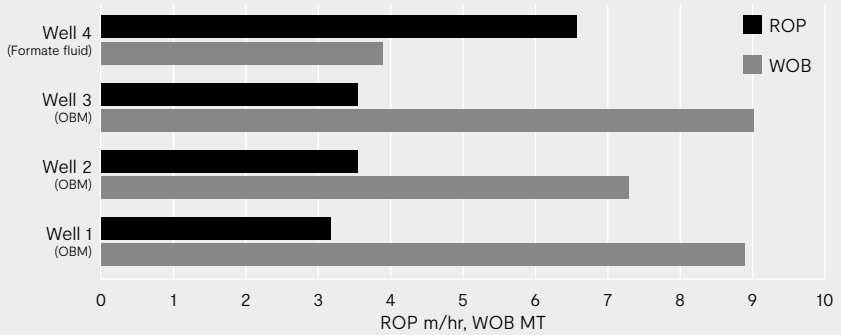
Total E&P, North Sea

Difficult cleanup from the first three gas wells drilled and completed in the Martin Linge HPHT field motivated Total E&P to switch from OBM to cesium formate fluid for its fourth well.

The fluid change enabled Total to unlock reservoir value. A quick cleanup/production test verified that the production index doubled compared to the first wells.

Additionally, ROP (rate of penetration) increased significantly. Total says: "In reality, ROP was unlimited – but kept controlled to < 15 m/hr in shale and ~ 5 m/hr in pay-zone with the aim to control gas and torque levels." This was achieved using the same bit type with a startling reduction of 56% in weight on bit.

Average ROP and WOB for all four Martin Linge gas wells



ROP significantly increased, even with low WOB, when using cesium/potassium formate drill-in fluid.

Hole instability issues and pack-offs were previously experienced through intervals of shale and coal. Using cesium/potassium formate drill-in and completion fluid with its optimised rheology reduced the overall stress of the open hole. The fourth well was problem-free and set a new standard of operational efficiency.

In summary, cesium formate's beneficial properties enabled faster drilling, much-improved hole stability, greater operational efficiency, excellent hole cleaning and a doubling of PI compared to the first three wells.

SPE 189550.

performance through simplicity

Sinomine Specialty Fluids

formatebrines.com

Head office
Ocean House, Hareness Circle
Altens Industrial Estate
Aberdeen AB12 3LY
Scotland
T (44) 1224 897 229
E enquire@sinominecorp.com

Europe
Kystbasen
Tranesvegen 29
NO-5347 Ågotnes
Bergen, Norway
T (47) 55 70 70 52
E enquire@sinominecorp.com

China
39th floor, RAYZONE
161 Jinze Road
Fengtai District
Beijing, China
T (86) 10 5881 5531
E enquire@sinominecorp.com

Americas, Asia, Middle East and Africa
T (84) 94 887 4428
E enquire@sinominecorp.com

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