

The Environmental Brine

Cesium formate brine for
challenging well constructions



What is cesium formate brine?



Cesium formate brine up to 2.30 g/cm³ (19.2 lb/gal) is produced at our mine in Canada.

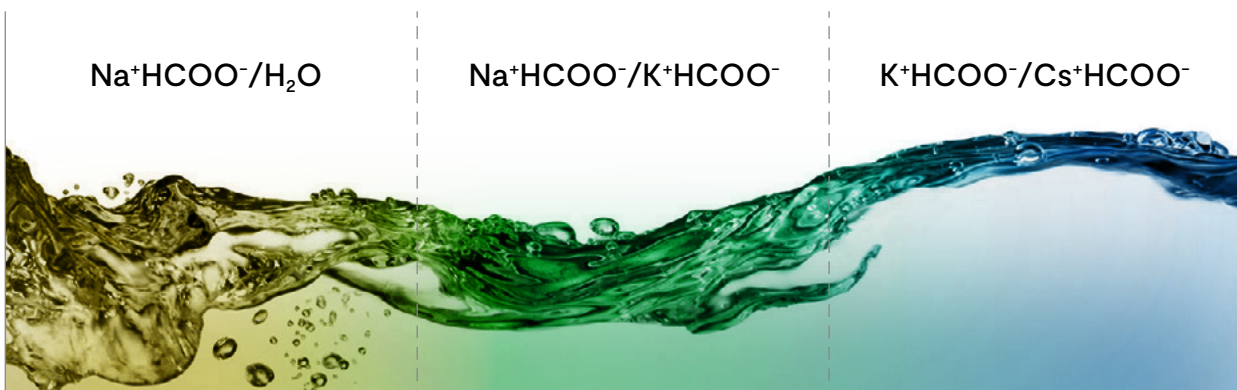
Sodium, potassium and cesium formate are naturally occurring organic salts. When diluted with water these highly soluble substances form high-density, alkaline brines for drilling, completion, workover and intervention operations. Cesium formate brine is the heaviest with solids-free densities between 1.57 g/cm³ (13.1 lb/gal) and 2.30 g/cm³ (19.2 lb/gal).

H₂O
1.00 g/cm³
8.3 lb/gal

Na⁺HCOO⁻
1.30 g/cm³
10.8 lb/gal

K⁺HCOO⁻
1.57 g/cm³
13.1 lb/gal

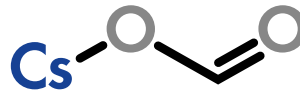
Cs⁺HCOO⁻
2.30 g/cm³
19.2 lb/gal



Formate brines are available for oilfield operations in densities up to 2.30 g/cm³ (19.2 lb/gal).

Cesium formate brine profile

Chemical formula	CsCOOH
Molecular weight	177.92
Appearance	Colourless liquid
Boiling point (2.30 g/cm ³)	122 to 145°C
pH	9 to 11
Viscosity (at 20°C)	1.7 to 10 cp
Solubility in water (at 20°C)	84.6 to 86.6%
Dissociation constant (pKa)	3.75
Vapour pressure	400 to 1700 Pa



Chemical structure of cesium formate.

Cesium formate brine from Sinomine Specialty Fluids has a concentration range of 60 to 84% cesium formate. This noncombustible, nonexplosive liquid has low vapour pressure and is not radioactive. It is produced at our Tanco mine in Manitoba, Canada from pollucite ore, which is ground and processed into cesium formate.

Cut risk to rig crew and the environment



PHOTO: ACCENT ALASKA/ALAMY

Cesium formate brine greatly reduces operators' risks of environmental damage. It meets the demanding standards set by environmental authorities around the world, such as the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) in the United Kingdom and the Norwegian Environment Agency.

Since it was first used in the oilfield in 1999, cesium formate has become the environmental brine of choice for sensitive environments worldwide, including the North Sea where it has completely replaced zinc bromide. It's proven to decrease well construction time, cut costs and reduce resource use accordingly.

Calculate the true cost of your brine

What are the hidden costs of brine used in your operations? Finding out the real cost of your fluid beyond a simplistic unit price/barrel comparison is a useful exercise. **BrineWise™** software helps to achieve this by translating health, safety and environment (HSE) issues into comparative cost units to help purchasing decisions in a consistent and transparent manner. For your free program, please email enquire@sinominecorp.com.

Leading oil and gas operators have successfully used high-density cesium formate fluids for challenging wells since 1999.

Operators can save time and resources by using cesium formate for both drilling and completion operations, or by utilising the same fluid in multiple wells by efficiently reclaiming and reusing the fluid onsite. To learn more about how our cesium formate-based fluids can improve your operations, please download our brochures from formatebrines.com/brochures.

We use an innovative leasing business model to reclaim cesium formate that encourages preservation and reduces waste. It provides several environmental and safety benefits to decrease risk and improve your operations:

- Cesium formate is halide-free and easily handled, unlike zinc and calcium bromides, which are acidic and can cause severe burns
- The formate ion biodegrades easily in fresh water and salt water, and the cesium cation does not bioaccumulate
- No need to add biocides
- Low environmental toxicity – with a CEFAS gold rating, cesium formate brine is considerably safer and more environmentally compatible than alternative high-density fluids

Cesium formate brine is ideal for sensitive environments.



Stamp of approval

Our cesium formate brine meets CEFAS's 'gold standard.'



As cesium formate-based brines have been used globally since 1999, effects on the environment and humans are cataloged in the literature. Results of studies show that these unique brines fulfill high environmental standards and are by far the best choice of all high-density fluids used in the oil and gas industry.

CEFAS approved

Cesium formate brine is ranked gold by CEFAS – its top environmental classification, which means it scores strongly on low toxicity, biodegradation and bioaccumulation. The ranking is calculated by using the CHARM model, which takes the ratio of Predicted Effect Concentration against No Effect Concentration and expresses it as a hazard quotient. For cesium formate brine, this is less than one.

Potassium formate falls outside of CEFAS's CHARM criteria and is assessed through the Offshore Chemical Notification Scheme (OCNS) grouping technique. Again, this formate brine gains the highest environmental ranking with its position in Group E, which is the cluster containing the least environmentally hazardous substances.

QUOTE

In deploying cesium formate brines in these fields, Total has created new Health, Safety and Environmental standards for completion and workover brines in the North Sea.

Total, Drilling Contractor, May/June 2007

Intertek-Metoc completes environmental assessment

A comprehensive lifecycle assessment of formate brines was completed by Intertek-Metoc. Key conclusions are:

- Quantitative risk assessments, following recommended approaches detailed in the Oslo Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), indicate that use and discharge of formate brine, in a manner similar to several test cases, does not pose a significant risk to the environment
- Formate brine drilling and completion fluids present operators with opportunities for minimising environmental impact

GESAMP gives cesium formate a low-impact score

The UN-backed Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) operates a rating scheme for chemicals and other substances. It finds cesium formate i) practically non-toxic or non-toxic to marine organisms and ii) slightly toxic or practically non-toxic to freshwater organisms.

As cesium and potassium formate brines are used globally, many other approvals have been granted, including the following:

- Ecotoxicological Harmonised Offshore Chemical Notifications Format Scheme (HOCNF) certificates for chemical use offshore
- Registered under REACH. This is the EU's Registration, Evaluation and Authorisation of Chemicals scheme, which documents potential environmental and health impacts of chemicals
- Entry in the Danish Product Registry in compliance with the Danish Working Environment Act

For copies of relevant certificates, please visit formatebrines.com/regulatory or email enquire@sinominecorp.com.

Highly biodegradable



Cesium formate does not bioaccumulate in aquatic or terrestrial organisms.

Cesium formate brine does not biodegrade under normal operating conditions, but safely biodegrades when diluted in the ocean. Fresh- and saltwater bacteria quickly break down the formate ion preventing it from bioaccumulating. Although the cesium cation remains unaffected by degradation, no severe effects of elevated cesium levels in the environment have been reported.

Due to the organic nature of the formate ion (HCOO^-), biodegradation tests are required by authorities before permission is given to discharge formate fluids to the environment. As PARCOM-recommended procedures for biodegradability do not exist, the most widely accepted alternative is a 28-day ready biodegradability laboratory test carried out under aerobic conditions. Shell Research¹ at its Huntingdon Research Centre in England completed such procedures. It performed 301D Closed Bottle Tests on sodium, potassium and cesium formate. In addition, Shell Research completed chemical oxygen demand (COD), BOD5 and 301E (modified OECD screening) tests on sodium and potassium formate.

All tests undertaken by Shell show formate brines to be readily biodegradable. They all pass the 'time window criterion,' i.e. substances that achieve 60% biodegradation within ten days of attaining a 10% level.

Our own research also supports Shell's findings. In two separate biodegradation tests for cesium formate brine², 79% and 66% of formate was degraded within 28 days when tested in seawater. In fresh water, 83% and 79% degradation of the chemical has been measured in the same time span.

QUOTE

The HSE risks of working with zinc bromide were deemed as unacceptable therefore cesium formate became the only fluid capable of delivering this objective.

BP, OTC 19242

1. Howard, S.K., et al. (1996). 'Formate Drilling and Completion Fluids – Technical Manual'. Shell Report SIEP 96-5091.
2. Cabot (2012).

Low environmental toxicity



With its low toxicity and biodegradability, cesium formate is the safest environmental choice of all high-density brines.

Cesium formate brine has significantly lower toxicity than other high-density brines. For the offshore oil and gas industry, the most relevant environmental tests are those detailing its effects on aquatic life.

The environmental consultancy Gaia compared cesium formate to zinc bromide and states: “Toxicity of zinc bromide to the test species is clearly at least two orders of magnitude higher than that of cesium formate. In the freshwater environment, the difference is in the order of one magnitude.” Aquatic invertebrate data for cesium formate brine is collated in the table below.

Aquatic invertebrate data

Organism	Endpoint	Cesium formate
Marine environment: Copepod (<i>Acartia tonsa</i>)	EC50 (48 h)	340 mg/l
Brackish water: Mysid shrimp (<i>Americamysis bahia</i>)	EC50 (50 h)	521 mg/l
Fresh water: Water flea (<i>Daphnia magna</i>)	EC50 (48 h)	>100 mg/l

No biocides required

For the past 25 years, cesium and potassium formate brines have been successfully used without biocides as drilling, completion, workover and suspension fluids in over 450 well operations.

An ideal fluid should be biodegradable when discharged to the environment, but biocidal when used in oilfield applications. In most drilling and completion fluids, biocides are added. As these are intended to kill living organisms, many biocidal products pose significant HSE risks and should be avoided if possible.

Shell testing¹ supports our field experience, specifically that formate brines can be successfully used without adding biocides.

QUOTE

The findings of the study indicate that the discharge of moderate amounts of formate brines is not likely to lead to potentially significant negative impacts on the marine environment.

ENI, SPE 94477

1. Howard, S.K., et al. (1996). 'Formate Drilling and Completion Fluids – Technical Manual'. Shell Report SIEP 96-5091.

Safer for rig crews

Cesium formate is not only environmentally friendly, but is the least corrosive of all high-density brines. For the 25 years cesium formate has been used in the oilfield, no occupational health issues relating to cesium formate have been reported.

Cesium formate brine delivers excellent test results compared to conventional fluids for dermal toxicity, eye irritation, skin sensitisation and mutagenicity. Furthermore, unlike zinc and calcium bromides, formate brines pose significantly less risk of burns to personnel handling the fluid.

Reducing our environmental impact

Managing and working to mitigate the impact operations have on the environment is a core element of our environmental policy. Consequently, we work hard to recycle and reuse cesium formate brine to reduce our footprint and costs to clients.

We operate an innovative, award-winning leasing scheme as a central element of our sustainable business policy. With this model, we retain ownership and stewardship of the chemicals at all times and charge clients for use. At the end of the project, the contaminated fluids are returned to us for reclamation at specially designed plants in Scotland and Norway, processed into clean brines using our proven technology, and leased out again. This approach cuts waste significantly and enables the brine to be used cost effectively in multiple wells. The result is better chemical management with clients joining us in a common interest to:

- Conserve chemicals, which reduces overall raw material, water and energy use
- Minimise waste, as the cost of disposal is moved from the user to the chemical provider

The sustainable chemical leasing business model has been recognised by awards from the United Nations Industrial Development Organization (UNIDO). Our approach allows clients to concentrate on their projects knowing that we are responsible for cleaning the fluid and recycling it into clean brine at the end of operations.

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The use of the same fluid system for both drilling and completion gives the additional benefits of simplified operations, reduced waste, and elimination of fluid incompatibility problems.

Statoil, SPE/IADC 105773



The comfortable choice – personnel using cesium formate brine only require standard personal protective equipment to handle the fluid.





performance through simplicity



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