

FORMATE MATTERS

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News and opinion from Cabot Specialty Fluids

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Statoil rewrites the rulebook



Photo: Statoil

With record-fast HPHT completion, exceptional well control and noteworthy productivity levels, Statoil is setting new standards with Kvitebjørn, its North Sea gas/condensate field.

Kicked into history

Statoil's challenge in developing Kvitebjørn lies in drilling long deviated wells through shales into reservoirs with pressures up to 81MPa (11,700 psi) and temperatures as high as 155°C (311°F). Difficult HPHT wells of this type are prone to well control incidents caused by barite sag and gas diffusion into conventional drilling muds. Reports state that there is normally one well control incident for every HPHT well drilled in the North Sea.

Statoil's solution to this risky problem is to drill and complete their Kvitebjørn wells with high-density cesium formate brine that contain no barite and have a low solubility for gas. This strategy has been an outstanding success. "So far, we have drilled nine HPHT wells from the Kvitebjørn platform without any well control incidents, apart from one incident of lost circulation in a depleted reservoir section," says Per Cato Berg, Lead Drilling Engineer in Statoil for Kvitebjørn. "This

confirms our experience with formate brines in the Kristin and Huldra HPHT fields. In total, we have completed close to 40 HPHT drilling or completion operations with formate brines over the past six years and, apart from the one occurrence of lost circulation, we've had no well control incidents."

Cesium formate brines have been used as combined drilling and completion fluids in Kvitebjørn since the inception of the drilling programme. According to Statoil's recently published SPE paper 105733, "Drilling performance was generally very good with moderate to high ROP, good hydraulics, and no incidence of stuck-pipe." This included drilling all nine Kvitebjørn reservoir sections, with lengths varying from 250 to 600 m (820 – 1,970 ft) and angles of 20° to 45°, and the 705 m (2,312 ft) reservoir section of an exploratory extended-reach well drilled at 69° into the neighbouring Valemon field.

Ready, steady, go...

With Kvitebjørn, Statoil is claiming the record for the fastest HPHT completion ever performed in the North Sea. One of the last wells, A-6, was drilled to a depth of 5,254 m (17,237 ft) and then completed in only 12.7

days with an operational factor of 98.1%. According to the Rushmore database, this is the fastest well HPHT completion ever performed in the North Sea.

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Job completed

Of the nine wells that have been constructed so far, two have been completed with cemented liners and five with sand screens. Cesium formate brine was used throughout as the completion fluid. No corrosion or fluid instability issues were experienced.

In addition, all Kvitebjørn wells show very good production rates, according to Per Cato Berg. One important reason is the fluid. "Supported by our tests and data, we feel that cesium formate gives the best productivity for the wells. We have tested formation damage with water- and oil-based alternatives, and cesium formate comes out best."

Managing the pressure...

As the Kvitebjørn wells have moved directly from completion to production, reservoir pressure is slowly being depleted. With further wells to drill, Statoil is in the process of introducing a new drilling technique to deal with the reservoir pressure depletion, namely

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Barite sag proves a challenge in high-angle HPHT wells on world's largest offshore HPHT field

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Remarkably, victims suffering chemical burns from chloride and bromide brines feel no initial pain, say doctors from Aberdeen Royal Infirmary

4 Smooth operator

Test your oilfield knowledge and win a Garmin GPS!

managed pressure drilling. Combined with an advanced modeling programme from SINTEF in Norway, this will allow Statoil to accurately monitor and regulate wellbore pressures and give greater control over the drilling process. Cabot Specialty Fluids responded with a 'designer mud', based on cesium formate, with carefully sized particles to plug fractures and protect the formation. "This is the first time this specially designed fluid will be used", says Gunnar Olsvik, Scandinavian Operations Manager in Cabot. "The whole operation breaks new ground, so we're excited to see the results."

"Using cesium formate brine as our drill-in and completion fluid gives the best well productivity," says Per Cato Berg, Lead Drilling Engineer for Kvitebjørn



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Report sheds new light on corrosion

'Formate brines – Compatibility with metals', newly published by Cabot Specialty Fluids, provides a new insight into formate brines' compatibility with oilfield tubular metals under HPHT conditions in the presence of O₂, CO₂ and H₂S. It couples laboratory tests and theory with field experience to give you a concise and up-to-date explanation of how formate brines protects HPHT well integrity.

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Cabot increases local support – Regional Manager Alan Carnegie at Cabot Specialty Fluid's new office in Singapore

PEOPLE

Formate expert to head R&D

Siv Howard, previously with Shell Research, Shell Expro and Hydro Formates, has been brought in as Research and Development Manager to increase technological support for Cabot Specialty Fluid's clients worldwide. Previously, she's worked as an external consultant for the company, but can now devote 100% of her energy on client support and research. "Joining Cabot Specialty Fluids is a natural step for me. I've always worked with formate brines, both in Hydro and Shell and I can use this experience for the benefit of Cabot's customers."

Educated at Technical University of Trondheim (NTH), Norway, Howard holds a PhD in Physical Chemistry. She is married with three children and has recently relocated from Houston to Aberdeen.

Siv Howard, new R&D Manager



Cabot goes east

Cabot Specialty Fluids has established a regional office in Singapore. Run by Regional Manager Alan Carnegie, the new office gives Cabot a platform to increase marketing efforts towards all prospective customers, from west of China through South East Asia to Australia. Over the past two years, Cabot Specialty Fluids has noted the development of many HPHT fields in China and a growing interest for its cesium-based formate brines across Asia. "With the increasing number of HPHT prospects in Brunei, China, Indonesia, Vietnam and other countries, we're seeing more enquiries than ever before," says Alan Carnegie. "For example, BP Vietnam are looking to develop new areas in the Nam Con Son basin off the coast of Vietnam. Following the notable success of cesium formate brines in enabling challenging HPHT well constructions

in Norway, BP Vietnam is keen to evaluate cesium formate as a drill-in and completion fluid for their own HPHT operations. Other companies, such as CNOOC, Shell and Total, have all shown interest in high-density formate brines for forthcoming HPHT projects, so we're optimistic for future contracts," explains Carnegie.

Singapore's central location in Asia, its excellent airport, tradition for oilfield business and efficient import and export procedures were all good reasons for choosing the Island State for Cabot Specialty Fluids' first home in Asia. The office is located in the central business district on the 25th floor of One Raffles Quay, just 20 minutes from the airport by metro or taxi.

FACT FILE

Alan Carnegie

Position: Regional Manager Asia-Pacific, Cabot Specialty Fluids (S) Pte Ltd.

Age: 46

Education: BSc Chemistry

Experience: Twenty years' oilfield experience in technical service, QC, mud engineering operations, sales and business management. Initially with International Drilling Fluids Ltd. in Aberdeen, Alan Carnegie has worked for a number of other companies in production and stimulation chemicals, fracturing proppant, and cementing chemicals and equipment; the last ten years with responsibility for China, Asia and the Middle East markets.

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DID YOU KNOW?

Over a barrel

The word "barrel" only has one 'b', so have you ever wondered why the abbreviation, bbl, has two? Go back to the early 1860's when the oil industry was in its infancy. At this time, there was no standard container for oil, so barrels in all shapes and sizes were used. They could have been originally made for turpentine, fish, beer, just about anything in fact. It didn't take long before standards were introduced and by the early 1870's the

42-gallon barrel was adopted by the industry. As these barrels were mostly made of wood, the extra two gallons were added to compensate for leakage and evaporation during transportation. Standard Oil produced these in blue for its petroleum products. The colour was a guarantee for buyers that they had a true 42-gallon barrel. The blue barrel was naturally abbreviated to bbl and has been used ever since.



TOTAL beats barite sag on Elgin/Franklin

Trying to workover high-angle HPHT wells in conventional muds or brines is a no go. This was the conclusion made by TOTAL when carrying out remedial work on their Elgin G3 well in the North Sea during the development of the world's largest offshore HPHT field.

TOTAL originally attempted to use a synthetic oil-based mud (SBM) as a workover fluid in Elgin G3, but barite sag and the associated well control risk was a significant problem throughout the re-entry programme. The challenge was to find a solids-free workover fluid with an average down-hole density of 2.19 s.g./18.29 ppg that minimised damage to the sandstone formation, was non-hazardous, environmentally sound and maintained sub-surface metal integrity even when contaminated with acid gas.

Zinc bromide brine was considered, but ruled out due to its toxic, corrosive and formation-damaging properties. Instead, TOTAL selected cesium formate brine. The well was first displaced to surfactant-treated water-based mud, followed by a heavy viscous formate pill and 2.19 s.g./18.29 ppg cesium formate. A flow-check performed before and after circulating bottoms-up confirmed that the perforated well was static, and the remaining brine on the surface was filtered through filter-presses and cartridge filters while tripping out of the hole.

The packer's tail pipe was filled with a viscous gel debris barrier designed to prevent solids entering the tool while it was run in the hole. The packer was set without incident and a 3,500 psi pressure-test confirmed the effectiveness of the seal. Following this test, brine was filtered clean and the production tubing run without incident. The tubing-hanger was successfully landed and the cesium formate brine displaced to inhibited, filtered drill water. Finally, BOPs were

removed to allow installation of the Christmas tree and the well successfully flowed before temporary suspension.

TOTAL moved on to the next Elgin well, G1, with the cesium formate brine. Barite sag had also been evident during perforation and suspension operations using a SBM, but was easier to rectify as the well was near vertical. The bridge and cement plugs were drilled out using a milling assembly and the well successfully displaced to cesium formate brine. Following running of the packer,

production tubing and casing hanger, pressure testing confirmed the integrity of all surfaces. The remaining cesium formate was displaced to inhibited, filtered drill water and the BOP replaced with a Christmas tree before temporary abandonment.

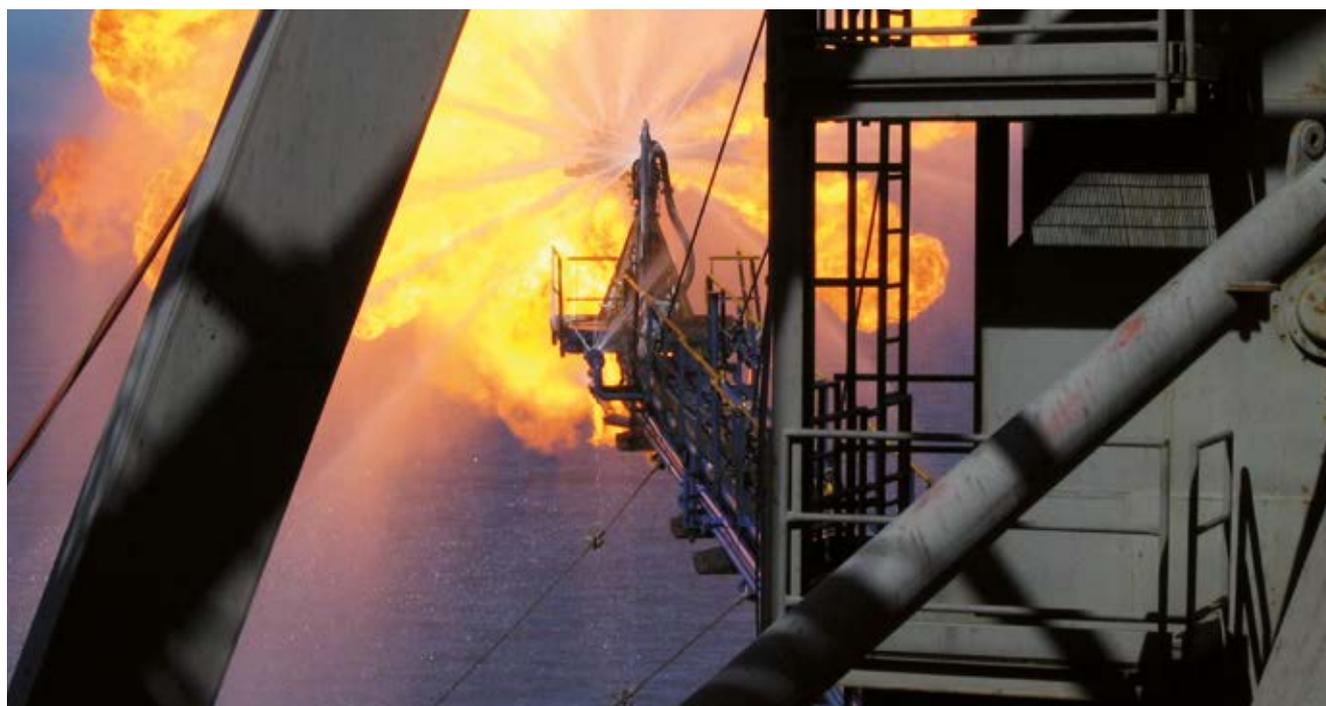
After this initial success, TOTAL employed the same strategy with their five remaining Elgin wells (G4 – G8). These HPHT wells were worked over by displacing to 2.19 s.g. cesium formate brine, recovering the completion strings, replacing casing-hangers, re-running

the strings and displacing the wells back to inhibited drill water. Pressure testing confirmed that the seals were sound and the wells were suspended prior to perforation and production.

On completion of this two-year workover campaign, TOTAL noted with satisfaction that the cesium formate brine had shown no signs of thermal degradation in these very hot wells (BHST of 190 – 200°C) and there had been no evidence of any corrosion or elastomer incompatibility. For the past seven years, cesium formate brine has been TOTAL's preferred and only HPHT well intervention fluid for workovers in the Elgin and Franklin fields.

The article is based on a presentation by TOTAL at the IADC World Drilling Conference, June 2007.

In production – Elgin/Franklin contributes approximately 5% of the UK's production of natural gas and condensate



MEET US AT THESE EVENTS

Cabot Specialty Fluids is participating in a number of conferences and exhibitions during the next few months. Come and see us!

10 – 13 September IQPC Formation Damage Control Conference, Kuala Lumpur

22 – 24 October SPE/IADC Middle East Drilling Technology Conference, Cairo

30 Oct. – 1 Nov. Asia Pacific Oil and Gas Conference and Exhibition, Jakarta

20 – 21 November IQPC HPHT 2007 Conference, Aberdeen

Presentation of papers

11 – 14 November 2007 SPE Annual Technical Conference, Anaheim, USA: SPE 110891, "Formate Fluids and Environmental Regulations: A global view of benefits and challenges"

4 – 6 December 2007 International Petroleum Technology Conference, Dubai, UAE: IPTC 11222, "REACH and the HSE Case for Formate Brines" (alternate and poster presentation)

TECHNICAL FORUM

Brine safety – it’s a burning issue

Mention the word ‘brine’ to the ordinary man or woman in the street and they will probably think of a benign salty solution used to preserve some of their favourite pickled foods. Mention the same word to someone working in the oil industry and they will probably think first of the ever-present risk of chemical burns and the need for full-body protection suits.

Why the difference in perception? The fact is that upstream oil industry workers associated with drilling and completion operations often have to work with halide-based (i.e. chloride and bromide) brines that cause very unpleasant skin necrosis injuries that take a long time to heal unless treated by surgical intervention. Splashes of the higher-density bromide brines into the eye can lead to destruction of the cornea and blindness, unless immediately flushed out with copious amounts of fresh water. It’s no wonder that workers in the oil industry, who have to deal with conventional brines on a daily basis, treat them with great respect.

The nature and scope of the skin injuries that can be caused by the ubiquitous calcium chloride and bromide brines is detailed in a

paper written by doctors from the Department of Plastic and Reconstructive Surgery and Burns in Aberdeen Royal Infirmary, Scotland¹. In this review of skin injuries to three oil workers treated in their unit they conclude that: “Skin exposure to CaBr₂ and CaCl₂ is characterised by the (initial) absence of pain, which may allow the development of deep injury in the unwary. Once established, the injuries are extremely painful and may progress unless arrested by adequate excision. When this is impractical....healing by (natural) secondary intention is slow”. In other words, if the skin necrosis cannot be cut out the damage extends to full thickness skin loss, which in one case described, “took a total of five months to heal”. The latter case was caused through contact with calcium chloride powder.

Fortunately, not all brines are so hazardous. The formate brines cover the entire density range of the chloride and bromide brines, but they are significantly safer to handle in powder and brine form. Formates are classified as being moderate irritants to the eyes and slight irritants to the skin, and contact will not cause any harm if they are washed off immediately with water. Clearly these materials



cannot cause such dreadful chemical burns of the type described above by the plastic surgeons. The formate brines have been in regular and prolonged use as drilling and completion fluids since 1993, during which time there has been not one recorded incident of chemical burn injuries to workers exposed to these products. It’s worth a thought when you order up your next batch of high-density brine...

As no initial pain is felt from burns caused by chloride and bromide brines, deep skin damage can proliferate

1. *Burns* Vol. 23, No. 7/8, pp. 634–637, 1997. Published by Elsevier Science Ltd.

For your copy of the paper, please contact us using the details at the bottom of this page.

Smooth operator – enter and win a GPS!

A	C	P	D	E	V	O	N	N
O	S	E	F	S	A	W	P	O
R	C	T	K	O	M	O	L	H
D	V	R	A	X	A	G	R	T
Y	I	O	O	T	E	Y	W	A
H	K	B	P	F	O	A	M	R
O	W	R	A	U	D	I	V	A
L	E	A	D	O	N	G	L	M
S	I	S	C	L	A	T	O	T



Why not test your oilfield knowledge? From the list of operators that have used cesium formate in their drilling and completion operations – shown below – we have selected ten and hidden their names in the grid on the left. They can be printed forwards, backwards, up, down, or diagonally. Find the ten that have been chosen, put them in an e-mail or fax, and send them to us. Please add your name, company and address for delivery of the gift. The first correct entry drawn out of the hat will be given a hand-held GPS from Garmin. **All other correct entries receive a Polo shirt! Good luck.**

Please send completed entries to Clare Ritchie at clare_ritchie@cabot-corp.com or fax (44) 1224 870089 by 31 August 2007.

Operators using cesium formate brine: BP, ConocoPhillips, Devon, Dong, Elf, Hydro, Marathon, MOL, Petrobras, Shell Expro, Statoil, Total, TXM, Walter Oil & Gas

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AND FINALLY...

**“You see things; and you say, ‘Why?’
But I dream things that never were; and I say, ‘Why not?’.”**
George Bernard Shaw (1856 – 1950), Dramatist