# BaraECD® NAF and SOURSCAV™ Scavenger Enable Safe Drilling of Sour Reservoir

## REMOTE EXPLORATION WELL WITH HIGH TEMPERATURE, RISK OF SEVERE LOSSES, AND POTENTIAL 35% $H_2S$ DRILLED WITH ZERO $H_2S$ AT SURFACE

OFFSHORE NORWAY

### CHALLENGE

- Up to 35% $H_2S$ present within the hydrocarbon gas in the reservoir
- Bottomhole temperatures as high as 150°C (300°F)
- Karstic formation with potential for severe downhole losses
- High fluid stability needed for wireline and data sampling program
- Remote location with limited mixing capabilities – 30 hours sailing to nearest supply base

### SOLUTION

Customized BaraECD® NAF system with the following features:

- SOURSCAV™ scavenger – to find and remove any $H_2S$ gas
- Low OWR of +/- 70/30 and reduced $CaCl_2$ salinity – to improve solubility of water soluble $H_2S$ scavenger SOURSCAV
- High lime concentration – to suppress $H_2S$ gas
- Extra emulsifiers and fine barite – to improve fluid stability up to 150°C

### RESULTS

- Operator experienced zero $H_2S$ at surface
- BaraECD fluid remained stable for entire 5-day logging program
- All fluids were delivered within agreed specification

### OVERVIEW

Extremely high temperatures, risk of severe downhole losses in a karstic formation, and presence of hydrogen sulfide ($H_2S$) led the operator to classify this remotely located exploration well offshore Norway as their most critical well in 2021. Through extensive technical and logistical planning, the well was successfully drilled by using BaraECD® non-aqueous fluid (NAF), pre-treated with SOURSCAV™ $H_2S$ scavenger. Although $H_2S$ was proven to be present within the formation fluids, no $H_2S$ was ever recorded at surface throughout the drilling of an 8½-in. reservoir section. The execution of the well was a success, and "Good quality on the fluid throughout the whole project" was reported by the customer.

### CHALLENGE

This complex exploration well required a customized fluid solution to meet several objectives. First and foremost, it needed to ensure stable and safe execution when drilling into a karstic reservoir section with a potential for up to 35% $H_2S$ gas within formation fluids. At the same time, it would have to withstand bottomhole temperatures (BHT) up to 150°C, requiring sufficient stability while executing a wireline program that could last up to 7 days. In addition, the nearest supply base was 30 hours sailing time from the offshore rig site, which presented yet another obstacle with regards to quickly accessing a sufficient fluid reserve volume in case of severe downhole losses when drilling into the karstic formation.

To properly mitigate the worst-case scenario of 35% $H_2S$, a non-aqueous drilling fluid would have to be formulated with an adequate concentration of $H_2S$ scavenger. Since the $H_2S$ scavenger SOURSCAV™ is water soluble in nature, solubilizing enough scavenger within the brine phase of the non-aqueous drilling fluid would require a significant change from the traditional fluid design. Finally, measuring any excess concentration of the active scavenger and ensuring that no free $H_2S$ was present within the drilling fluid were paramount to ensure a safe execution while drilling.

### SOLUTION

Halliburton Baroid's customized fluid solution combined a 1.30sg BaraECD NAF system at 70/30 oil/water ratio (OWR) with a total of 8.5 kg/m$^3$ of the $H_2S$ scavenger SOURSCAV. Ultra-fine grind (UFG) barite was also used, along with additional emulsifiers, to ensure enhanced stability during the prolonged wireline logging program at 150°C BHT. The low OWR and a low salinity of only 50,000 mg/L of $CaCl_2$ allowed for the high concentration of 8.5 kg/m$^3$ of water soluble SOURSCAV to be sufficiently solubilized into the brine phase. In addition to the $H_2S$ scavenger SOURSCAV, the fluid also included up to 20 kg/m$^3$ of lime as a secondary barrier to help suppress $H_2S$.

An extensive offshore testing program and procedure was developed, and two extra mud engineers were mobilized to the rig with the sole task of conducting hourly lab testing of

SOURSCAV concentration and $H_2S$ content, which were monitored via a garret gas train (GGT). Mud engineers were brought onshore for training to ensure that all crew involved in lab testing were familiar with the specialized test protocol. In addition, all mud engineers underwent a pre-job presentation of the design of service (DoS) and execution plan before going offshore.

A total of 1,800$m^3$ of 1.30sg BaraECD NAF containing 8.5 kg/$m^3$ (3.0 lb/bbl) of SOURSCAV was mixed and made available at the rig site, using additional storage boats for convenient access to extra supply as needed.

## RESULTS

The well was delivered safely and according to plan, thanks to the innovative fluid formulation. The BaraECD NAF remained stable for a total of 5 days of wireline logging and stayed within the agreed upon specification. Samples taken from the reservoir showed that >2,000 ppm $H_2S$ was present in the reservoir fluids but no $H_2S$ was ever recorded at surface, demonstrating that SOURSCAV was effectively scavenging any $H_2S$ before it could reach surface. The frequent lab testing of SOURSCAV and $H_2S$ levels were successfully executed and results reported along with daily mud reports. No significant drop in SOURSCAV concentration or the presence of any $H_2S$ was detected throughout the whole well.





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