ThermaFOAM CO2 Foam System for High-Temperature Wells

The future of high-temperature brownfield CO₂ fracturing

A truly innovative chemical solution

CO₂ foam fracturing is typically performed in depleted formations to enhance flowback of the fracturing fluid and to increase initial post-treatment production. It is also used to stimulate water-sensitive formations. A drawback of this fracturing method has been that no CO₂ foam fracturing fluid has been able to withstand higher-temperature environments while retaining high proppant pack conductivity. Until now.

The ThermaFOAM® CO2 foam system for high-temperature wells is a new and unique chemical system specifically designed for fracture applications in wells with bottomhole static temperatures (BHSTs) between 200 and 300 degF [93 and 149 degC].

The innovative ThermaFOAM CO2 system chemistry enables Schlumberger to formulate noncrosslinked gels that deliver viscosity equal to or better than the industry-standard foams of low-pH guar, or derivatized-guar, crosslinked fracturing fluids. ThermaFOAM CO2 systems deliver those results at significantly lower polymer loadings and with a reduced number of additives.

Applications

- Hydraulic fracturing applications for 40–70 quality foam systems
- BHSTs from 200 to 300 degF [93 to 149 degC]

Benefits

- Improved production from new and mature wells
- Increased retained conductivity of proppant pack

Features

- Stable rheological performance over an extended temperature range
- Lower polymer loadings
- Simplified additive system
- Environmentally friendly system

Representation of a conventional guar crosslinked polymer (left) and ThermaFOAM CO2 biopolymer (right) at a semi-molecular scale. The ThermaFOAM CO2 chemical structure renders more viscous foams and enhanced proppant transport in high-temperature CO₂ environments.
Tailored solutions for high-temperature CO₂ treatments

In the past the most common method of facilitating high-temperature CO₂ fracturing was to increase polymer loading to provide additional stability. The ThermaFOAM CO₂ system is a CO₂-compatible product that uses the CO₂-polymer interaction to create stable and robust foam systems that allow polymer-loading reductions of up to 50%.

The reduction in polymer loading, combined with improved well performance and the elimination of the need for a crosslinking gel, has resulted in a fluid system that maximizes cleanup of the proppant pack within the fracture.

Laboratory experiments have consistently demonstrated retained conductivity of more than 90% for ThermaFOAM CO₂ systems. This is a dramatic improvement over competitive CO₂-compatible fluid systems.

Shorter time to sales

Significant reductions in time to sales can typically be expected for wells fractured using the ThermaFOAM CO₂ foam system compared with wells stimulated using conventional fracturing technology.

In this standard proppant pack conductivity test at 200 degF, the ThermaFOAM CO₂ system demonstrated 97% retained conductivity after being contacted with CO₂. It was compared with a crosslinked derivatized guar fluid system with loading appropriate to the temperature.

ThermaFOAM CO₂ Nominal Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Temperature range</td>
<td>200 to 300 degF (93 to 149 degC)</td>
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<tr>
<td>Proppant compatibility</td>
<td>Sand, common precured resin-coated proppants, intermediate-strength proppants, high-strength proppants</td>
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<tr>
<td>CO₂ foam quality</td>
<td>40–70</td>
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<td>Mix water requirements</td>
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<tr>
<td>pH</td>
<td>4.0 to 11.0</td>
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<tr>
<td>Water hardness</td>
<td>Total: less than 2,500 mg/L, Calcium: less than 1,000 mg/L, Magnesium: less than 600 mg/L</td>
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<tr>
<td>Clay stabilization</td>
<td>Potassium chloride (2 % to 7 %)</td>
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