Case History

TerraTherm™ High Performance Water-Based Drilling Fluid Proves Successful on Geothermal Wells with up to 250ºC Bottom-Hole Static Temperature, Azores Volcanic Islands

Newpark's technology, operational experience and deep domain expertise in geothermal drilling ensured successful operations in the remote island chain.

CHALLENGE	SOLUTION	RESULT
• Geothermal gradient of 250°C to 1,000m (TVD) • Total losses from top formation	• TerraTherm™ high-performance water-based drilling fluid • Pro-active fluid formulation management • Expertise in robust project planning	• Mitigated losses to maintain drilling • Successfully drilled highly challenging wells 20% faster than planned (24 days vs. 30 days)

OVERVIEW

The Azores are located above an active triple junction between three of the world's major tectonic plates. The volcanic geology, associated with the occurrence of many springs in the foothills, resulted in a basin with high geothermal gradient.

The Ribeira Grande geothermal field lies on the northern flank of the Fogo Volcano. The permeability of this geothermal reservoir is associated with fractures in the volcano's geology.

The project scope was to drill 4-5 new wells (1,100 – 1,200m TVD) to develop the current field in the Island of Sao Miguel, followed by 3-4 wells (30° deviated, 2,000m TVD / 2,229m MD) to develop production on the island of Terseira.

CHALLENGE

Drilling in basalt rocks with high geothermal gradient (250 °C at 1,000m TVD) generates natural challenges associated with high temperature, including:

- Product degradation
- Abnormal drilling fluid water evaporation

NEWPARK FLUIDS SYSTEMS

Case History

- Abnormal physical behavior of the drilling fluid
- Drilling fluid total losses at various depth (up to 2.895 m^3/well)

High temperature is a root cause for product degradation, negatively affecting the performance of the drilling fluid. At the same time, evaporation in conjunction with product degradation results in abnormal physical behavior of the drilling fluid which requires dilution of compensation water and fluid products to be carefully controlled. Maximum mud weight required is expected to reach 1.1 SG.

Additional challenges often associated with thermal basins include the nature of the geology and stratigraphy which can result in total losses at various depths, starting in this particular field from the top section (60-70m).

SOLUTION

TerraTherm, Newpark's high-performance water-based drilling fluid is designed specifically for geothermal applications and has been developed with our 30+ years of worldwide geothermal drilling experience. For this project, the fluid system was fine-tuned to match the unique field challenges of the wells, including the addition of a freshwater medium-high temperature resistant polymer.

Continuous management of the drilling fluid was essential to proactively adjust the formulation and maintain dilution rates, including reacting immediately to major downhole total losses encountered from 60-70m. Newpark's supply chain planning was essential to the project success, establishing a continuous supply of product which enabled the drilling fluid to be consistently built and maintained throughout the well.

Azores Geothermal field by the numbers

Temperature and depth	250 °C at 1000 m
Expected time to drill each well (average per well)	30 days
Actual time to drill each well (average per well)	24 days
Rate of dilution (average excluding mud loss compensation)	2.5 to 4 (m^3/m^3)
Total Downhole losses (average)	1,254 m^3 / well
Total Downhole losses (maximum recorded)	2,895 m^3 / well

RESULTS

Successful drilling in extreme environments, such as those in the Azores geothermal field, requires extensive experience and expertise in drilling fluids technology. The decision to leverage Newpark's TerraTherm, high-performance water-based drilling fluid and our extensive operational success in geothermal drilling were key to the success of the project. The average time needed to drill these new wells on the island of Sao Miguel was 6 days shorter than expected (24 days vs the original 30 days planned).