



NanoFIX™-Enhanced SBDF Achieves Stable Drilling Through Tectonically Stressed Flysch Formation with Zero Stuck Pipe Events

Through a custom-engineered Synthetic-Based Drilling Fluid (SBDF) with nanomaterial wellbore strengthening, Newpark enabled the successful drilling of challenging Flysch formation, eliminating stuck pipe incidents and minimizing non-productive time.

CHALLENGE	SOLUTION	RESULT
<ul style="list-style-type: none"> • Complex Flysch lithology and tectonic stress regime. • Severe wellbore instability, high-density fluid requirements, and tight ECD management. • Multiple complicating factors including aquifers, chert, losses, and overpressure. • High sidetrack rates and wellbore failures in offset wells. 	<ul style="list-style-type: none"> • Engineered SBDF with NanoFIX™ nanomaterial for wellbore strengthening. • ClearBridge™ software used to optimize bridging and sealing properties. • High OWR and low filtrate loss achieved through fine-tuned additive balance. • Lab-validated formulation ensured stability under extreme downhole conditions. 	<ul style="list-style-type: none"> • Drilling through Flysch formation completed with no stuck pipe incidents. • Minimal NPT, limited to brief back reaming operations. • Stable wellbore maintained through both density reduction and restoration cycles. • Continuous optimization using ClearTrack™ software ensured effective hydraulics and hole cleaning.

CHALLENGE

Newpark was selected by an International Oil Company to provide Drilling Fluids and Services following a competitive tender process. The strength of Newpark's proposal was its in-depth knowledge of the field and its challenges, combined with an established local presence—including a warehouse, engineering office, and two Liquid Mud Plants within the country.

The project required drilling through challenging intermediate intervals in the **Flysch formation**, known for **wellbore instability caused by clay reactivity, tectonic stresses, and other mechanical instability mechanisms**. From a drilling management standpoint, this demanded rigorous control of high-density fluids (> 16.7 lb./gal / 2.0 s.g.) while maintaining low filtrate loss. Success depended on precise control of fluid density for mechanical wellbore stabilization, careful ECD management, and effective hole cleaning to avoid problems related to drilling brittle shale.

The **Synthetic-Based Drilling Fluid (SBDF)** design was intended to address these issues. The formulation was optimized, including incorporating **NanoFIX Wellbore Strengthening Material (WSM)** into the bridging package to further control fluid loss.

The **Flysch shale** is composed of claystone with siltstone and sandstone stringers. This complex lithology is associated with severe tectonic stress, typically within a strike-slip or thrust faulting regime. Such conditions require increased planning, testing, and technical recommendations on drilling fluids to successfully and safely drill the formation.

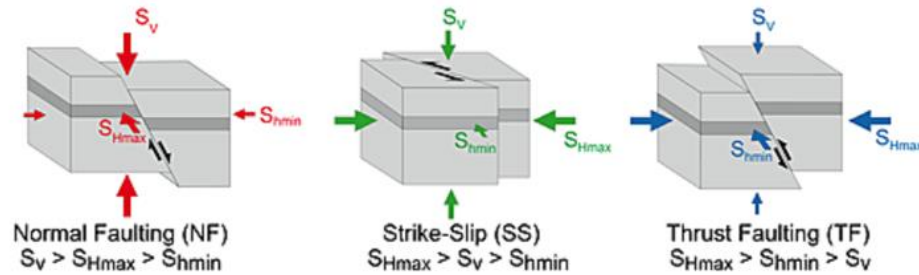


Figure 1: graph of the different movements of a fault

Key requirements included:

- Utilizing geomechanical studies, offset well data, and cuttings/cavings analysis to predict and control wellbore instability.
- Selecting and maintaining the correct fluid density for drilling the Flysch shale.
- Improving borehole stability through optimized bridging and sealing agents that protect formations by sealing microfractures and reducing pore pressure transmission.
- Ensuring sufficient carrying capacity to remove cuttings and cavings from the wellbore.
- Adjusting water phase salinity to minimize chemical osmosis.

Borehole instability was not the only challenge in this field. Other issues over and above the challenges related to drilling the Flysch added additional complexity to drilling these wells, including:

- Presence of aquifers in surface section requiring the use of environmentally friendly fluid additives.
- Hard, abrasive chert formations leading to low penetration rates and high torque.
- Hole cleaning challenges while drilling large-diameter sections through carbonate.
- Severe to total losses in fractured carbonate formations.
- Overpressure in the carbonate reservoir leading to use of high density, non-damaging reservoir drilling fluids.
- Subsequent risk of formation losses and differential sticking within the carbonate reservoir.
- Potential H₂S contamination in carbonate zones.
- Possible presence of over pressured Flysch stringers in the carbonate reservoir.

Most offset wells experienced sidetracks, with one well requiring as many as nine. Failures resulted from shear stress, drilling parallel to bedding dips, and intersecting formation fractures due to the very high in-situ stresses common across the area.



SOLUTION

As part of the improvement process, the following benchmarks were established during the design of the **Synthetic-Based Drilling Fluid (SBDF)**:

- Engineer the mud weight from a minimum of 16.7 lb/gal (2.0 s.g.) in the upper Flysch to a maximum of 19.2 lb/gal (2.30 s.g.) in the lower Flysch above the carbonate reservoir.
- Use a **high Oil/Water Ratio (90/10 to 95/5)** to maintain good rheological properties at elevated mud weights.
- Achieve **very low HTHP filtrate loss (<1.0 ml/30 min at 186°F/500 psi)** with thin filter cake using a 5 µm aloxite disk to simulate tight formation.
- Provide a **rheology profile** that supports optimal hole cleaning even in the event of heavy cavings load.
- Use a **comprehensive package of bridging, sealing, and wellbore strengthening materials** to support borehole stabilization and microfracture sealing.

The SBDF was formulated to meet these specifications with the following key additives:

- **Optimized OptiMul LT & OptiPlus LT** emulsifier concentrations to stabilize the emulsion under challenging conditions.
- **OptiTrol FC** liquid fluid loss control agent to minimize fluid loss.
- Water phase salinity selected to balance formation water activity.
- **OptiVis HY** high-yield organoclay, and **OptiMod LT** rheology modifier added to achieve desired rheological properties.
- Careful dosing with **OptiWet LT** to improve oil wettability of solids.
- Barite was used as weighting agent.
- **Designed the bridging package using NewBridge™**, Newpark's proprietary bridging software. A blend of **TrueCarb** high purity ground marble **NewSeal** resilient graphite were selected to ensure effective bridging across the formation.

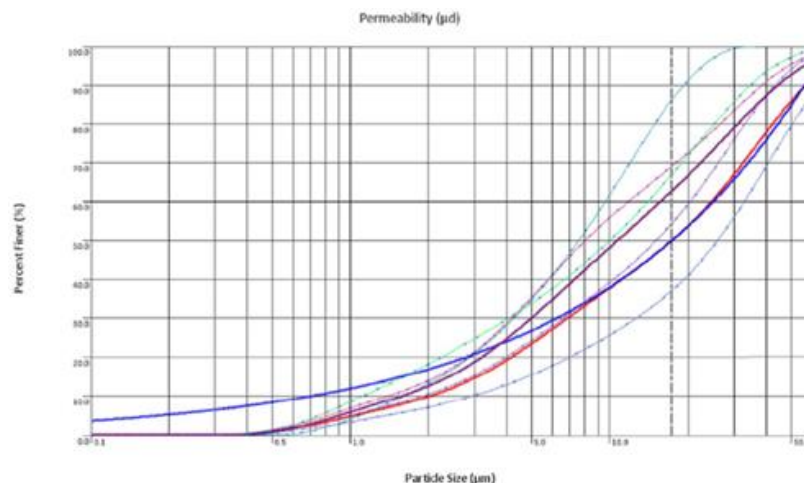


Figure 2: Curve of the Particle Size Distribution of formation microfracture and the ones of different Bridging Agents simulated by NewBridge™, Newpark proprietary Bridging software.



Extensive laboratory testing was conducted on various additives designed to reduce filtrate loss into microfractures. From this testing, **NanoFix** was selected as the primary Wellbore Strengthening Material (WSM).

Key advantages of **NanoFix**:

- No negative impact on Oil/Water Ratio or rheological properties.
- Enhanced microfracture sealing and borehole stability.
- Improved mechanical strength without altering the emulsion system.

RESULTS

Before spudding the Flysch sections, the project team reviewed offset well performance and incorporated lessons learned into the drilling program. Key operational practices—such as controlled tripping speeds, steady penetration rates, and stuck pipe mitigation procedures—were implemented to prevent formation breakdown during circulation re-establishment.

The engineered SBDF, combined with optimized drilling practices, **enabled the successful drilling of the Flysch formations with no stuck pipe incidents and minimal non-productive time (only a few hours)**, which was attributed solely to back reaming in the 12¼” section.

The correct mud weight proved to be the **first line of defense against borehole instability** in these overstressed, brittle formations. The 16.7 lb/gal mud weight provided sufficient mechanical stabilization without requiring an increase to the 19.2 lb/gal anticipated in the drilling program.

The **17½” hole** remained stable throughout drilling and even during fluid density reductions from 16.7 lb/gal to 16.1 lb/gal, which were applied to reduce bottomhole pressure and address formation losses. The mud weight was then restored to 16.7 lb/gal and maintained through the **12¼” section to TD**.

Hole cleaning efficiency and hydraulics were continuously monitored using **ClearTrack hydraulic simulation software**, which modeled downhole fluid behavior and minimized drilling risks.

Case History

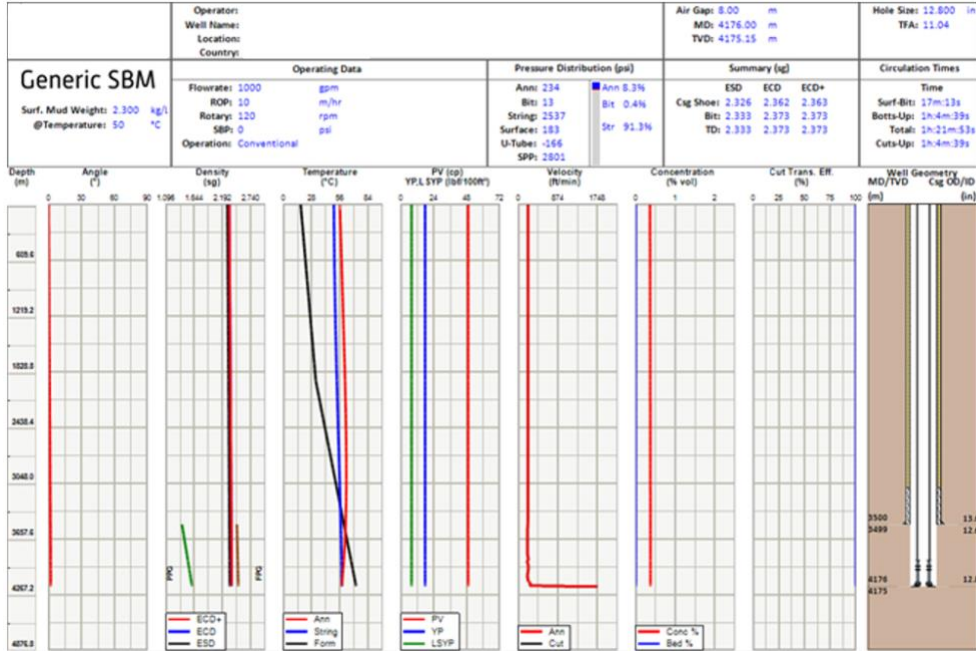


Figure 3: Example of Hydraulic simulation ran with ClearTrack, Newpark proprietary Hydraulic Simulator software.