# Synthetic fluid increases ROP by as much as 117%

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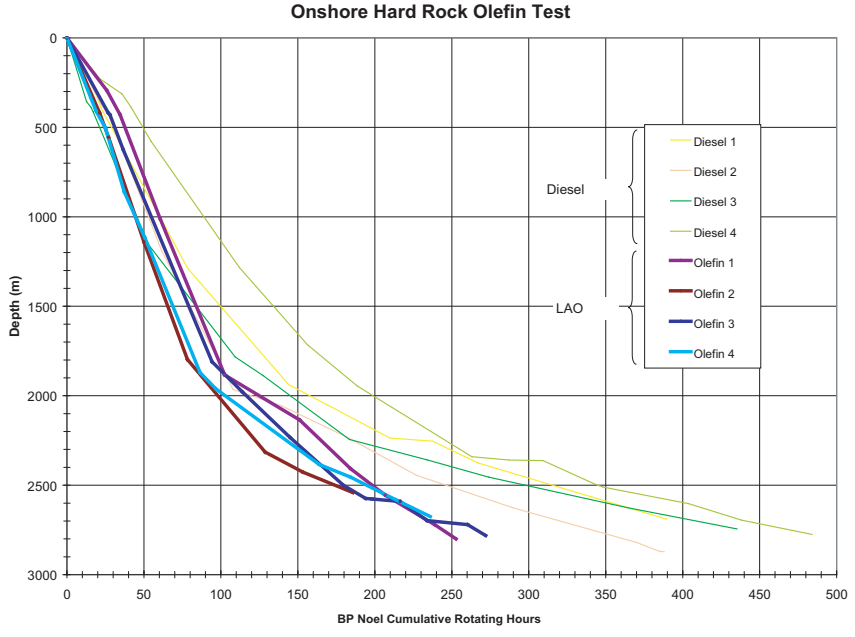
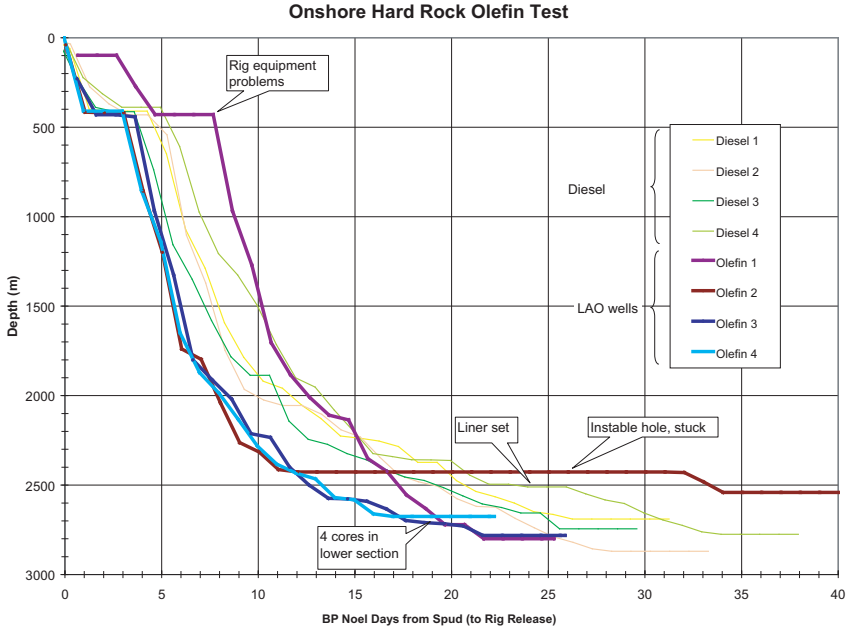
**THE OBJECTIVE WAS** to develop a synthetic olefin-base mud for onshore drilling that has a lower impact to workers' health and is more environmentally sound than diesel oil mud. After two years of drilling trials, primarily at the Noel field in Northeastern British Columbia, Canada, BP met this objective and also made an interesting discovery. The test fluid, Amodrill Olefin, accelerated the rate of penetration substantially. The olefin muds drilled more than 50% faster than diesel-base muds with similar properties, particularly in hard rock with compressive strength of more than 15,000 psi.




The olefin—clear, colorless, water-white, mobile and 99+% olefinic—is not new; offshore operators have used it for years. When applied to land for the first time just over two years ago, drillers set a new drilling time record, reducing record well drilling time to 2,800 meters (9,186 ft) from 26 days to 17.

More testing revealed that the initial results were repeatable. BP returned to areas in the field where four wells were previously drilled with diesel oil mud. Tests were conducted in the same geologic environment, using similar mud properties, drilling parameters and bits. Penetration rate improvements were most significant at greater depths where rock is harder. On average, ROP increased by 84% below 2,000 meters (6,561 ft), and by 117% below 2,500 meters (8,202 ft).

When considering an interval of 1,000 meters (3,280 ft) drilled below 2,000 meters (6,561 ft), a rate comparison of 3.2 m/hr (10.5 ft/hr) versus 5.8 m/hr (19 ft/hr) yields a total time savings of about 140 hours, or just under six days.

## A NOTICEABLE ABSENCE

Workers at the well immediately noticed something missing: the distinct odor of diesel at the drilling site. With Amodrill fluids, the fumes are not present to inhale or to be released into the atmosphere. The synthetic olefin product is also safer because of a significantly higher flash point of 116°C (240°F) versus 66°C (149°F) for diesel.

The test fluid also demonstrated some key environmental improvements. Fewer cuttings are generated, therefore, land requirements are decreased. Total mass needing remediation is smaller.

Laboratory studies at the University of Calgary during the past few years have demonstrated that olefins biodegrade quickly and are less toxic than diesel oil. Since the first field testing began at the Noel wells just over two years ago, several sites are now nearing a release point. For wells drilled with diesel oil muds, land turnaround typically occurs in the range of five to seven years. Evidence from the drilling trials suggests that turnaround for sites drilled with the synthetic olefin counterpart could be as

**Drilling Fluid Comparison**

| | Aromatic Content | Polynuclear Aromatic Hydrocarbon Content | Viscosity 40°C, cSt | Pour point | Flash point |
|---|---|---|---|---|---|
| | wt% | | | | |
| Amodrill | 0% | <0.001% | 2.09 | -18°C (0°F) | 116°C (240°F) |

short as two years. When considering that onsite cuttings composting typically costs C$10,000 per year, removing 3-5 years from the process could save drilling companies up to C$30,000-$50,000 per well. Reduced liability is an added benefit.

The University of Calgary's tests focused on several methods to determine the biodegradation and ecotoxicity of several drilling fluid types, including diesel and the synthetic olefin. Researchers added each fluid to loam subsoil at 2 g/100 g dwt soil. Microbial respiration was monitored for three months until activity stabilized. Researchers measured the total extractable hydrocarbons (C11-C60) and toxicity twice: first at the time of fluid application, then again after three months of bioremediation. The University's toxicity bioassays took on several forms: seed germination and root elongation of lettuce, canola and barley; earthworm survival; and luminescent bacteria response.

The studies concluded that out of the fluids tested, olefins displayed the fastest and most complete biodegradation, and the least ecotoxicity in soil to bacteria, plants and worms.

Although 71% of the diesel fluid disappeared through volatilization and biodegradation, extreme toxicity persisted after bioremediation. However, the bioremediation process itself is harmful to the environment, since the diesel oil mostly evaporates into the air as harmful hydrocarbon emissions.

**ROP Comparison by Threshold Depth**

| Threshold Depth | Diesel ROP | Amodrill ROP | % Improvement |
|---|---|---|---|
| 1,000 m (3,280 ft) | 7.9 m/hr (25.9 ft/hr) | 12.8 m/hr (42 ft/hr) | 62% |
| 1,500 m (4,921 ft) | 3.8 m/hr (12.5 ft/hr) | 6.9 m/hr (22.6 ft/hr) | 82% |
| 2,000 m (6,561 ft) | 3.2 m/hr (10.5 ft/hr) | 5.8 m/hr (19 ft/hr) | 84% |
| 2,500 m (8,202 ft) | 2.3 m/hr (7.5 ft/hr) | 5.0 m/hr (16.4 ft/hr) | 117% |

Note: These ROP numbers are weighted average ROPs by meters drilled by each bit. Bit records were used to calculate ROP over the entire section, removing tripping, non-productive time and other events from the analysis. The section considered is from threshold depth to total depth for all wells. Only 200mm bit runs were considered.

**Soil Test Results for Synthetic Olefins vs. Diesel**

| | Olefin | Diesel |
|---|---|---|
| Total Degradation after 93 days (degradation at 2% in soil for 93 days; difference in total extractable hydrocarbon at beginning and end of test) | 96% | 71% |
| Lettuce Seed Germination, Day 93 (germination relative to control soil after 93-day degradation of fluid in soil) | 88 | 4 |
| Earthworm Toxicity | | |
| Day 0 (addition of fluid) | None | 100% |
| Day 93 (degradation) | None | 100% |

At the same time, the studies conclude that olefins will biodegrade in months rather than the years it takes to treat diesel oil. The olefin is converted to biodegradation by-products ($CO_2$ and water) and biomass that enriches the soil. Cuttings from the synthetic olefin-base mud biodegrade faster for all processes that handle drilling waste.

## PERFORMANCE FIRST

The potential safety and environmental benefits of the synthetic olefin-base mud were proven in a laboratory. Field trials are providing additional evidence. Operators can save costs in treatment and liability, while protecting their workers and the environment.

The new fluid is achieving impressive rates of penetration, especially in hard rock. In a time period of about 10 days, the synthetic olefin-base mud is achieving depths that take diesel-base mud up to 14 or 15 days. More field trials are in the process to provide additional support for these numbers. ■