



Description of selected technologies

Roke Technologies - Quad Neutron

Increasing well production potential with the Quad Neutron Logging tool

TEO has successfully used Roke Technologies' Quad Neutron Logging tool to identify additional pay areas in existing wells at the Lovely and Beauty properties and to improve the targeting and use of other technologies. Quad Neutron is a revolutionary through casing and tubing logging tool that measures fluids saturation, porosity, lithology and qualitative permeability and identifies bypassed oil-bearing formations and high-water saturation zones.

How does Quad Neutron work?

The Quad Neutron is a nuclear measurement tool specially designed for through pipe reservoir evaluation. It's a four detector neutron tool that measures reservoir responses due to neutron bombardment. Two detectors are thermal neutron detectors, but of critical importance, two are neutron-gamma detectors.

When bombarded with high energy neutrons, reservoir rock and fluids not only create thermal neutrons, but also create numerous gamma rays (N-Gammas) from both neutron capture and activation. The Quad Neutron-Gamma detectors measure these responses, and the combination of thermal neutron and neutron gamma measurements are very effective at differentiating reservoir parameters.

Designed and tested to 150C and 15kPSI, the Quad can be used in harsh environments and with many wellbore configurations. The tool can be used to log with good accuracy through multiple strings (tubing, liner and casing), without requiring the production tubing to be pulled out of the well. It can also be run with a heat shield to increase the temperature range for deeper wells. The Quad's complex measurement suite is delivered with a simple telemetry and low power requirements.

Some interpretable parameters from the standard log presentation are: Porosity, including clay free porosity, Saturation, including the ability to differentiate between fresh water and heavy oil, Clay volume, Relative permeability, Relative bulk density, Dolomite identification in carbonate reservoirs, Pyrite and calcite identification in clastic formations, Differentiation between bitumen and moveable oil.

Quad Neutron Applications

- Logging While Tripping
- Shallow Gas
- Coal Bed Methane
- Conventional Oil and Gas water shut-off
- Conventional Oil and Gas bypassed pay
- Gas Migration related Cap Rock Identification
- Horizontal post completion remediation
- Oil Shale exploration
- Reservoir Monitoring
- Heavy Oil pad Open Hole replacement logging
- Frac Tracing with non-radioactive Boron Carbide

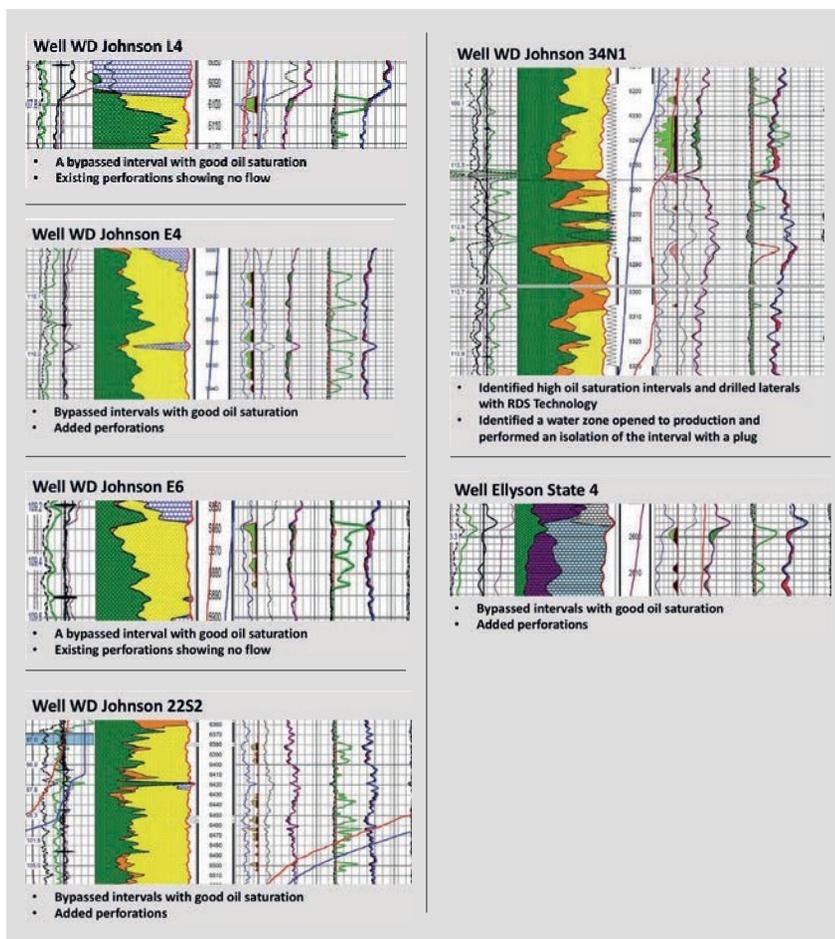


Impressive results in Lovely and Beauty Assets

The Quad Neutron tool has been successfully implemented in more than 40 wells in Lovely and Beauty assets for through casing logging, in an effort to identify additional oil bearing zones and increase the production potential of the wells. Results have been impressive as additional pay zones, perforated zones without flow and high- water saturation zones, have been identified.

By identifying bypassed oil zones it has been possible to plan and execute well interventions and to perforate new intervals. In wells where existing perforations were showing no flow, it was possible to re-perforate those intervals and restore production. Another positive outcome has been the identification of zones with high-water saturation, making it possible to isolate water zones and increase well potential by reducing the water cut.

The use of Quad Neutron in Lovely and Beauty wells has also provided the opportunity to improve the implementation of other technologies, such as plasma pulse and RDS, making it possible to identify prospective intervals to drill the laterals or to use plasma pulse to apply a selective stimulation.



TEO plans to continue to use the Quad Neutron Logging tool

The Quad Neutron logging tool has performed well to date and will be used in all fields to identify possible additional pay zones and to increase well production potential. It can also operate effectively in harsh environments, with high temperatures and high pressures, including in deep wells, such as TEO's Gomez Field, with depths of up to 22,000 ft.

The advantage of groundbreaking logging technologies

The dilemma for all down hole tool designs is to, not only measure environmental responses, including reservoir affects, but to understand and separate/correct all the interfering responses into meaningful singular reservoir characteristics.

Untangling the information hidden in the combination of Quad detector responses requires several techniques, including detector balancing, statistical normalization, and Quad Litho Log Overlay (QLO) methods. Without these techniques, the responses cannot be turned into singular reservoir parameters and that is key to why the Quad works where many other tools, such as those that apply spectral techniques and/or decay techniques, may not.

The Quad uses the difference between a porosity log created from thermal neutrons and another created from neutron gammas. Because these two measurements are generated from the same tool, with the same statistical variability, on the same pass, with balanced and complementary detectors, the difference is chiefly based on salinity, while almost all other effects are automatically normalized and usually do not need to be considered.

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