Improving Oilfield Service Efficiency

Operational efficiency allows energy companies to economically develop production from declining fields and from new fields in remote locations. In these challenging arenas, two oilfield services—hydraulic fracturing and resistivity logging—have benefited from significant efficiency improvements.

Achieving operational efficiency is mandatory for success in today’s business environment. Business publications and television programs are replete with articles and features describing how industrial companies are analyzing their processes and techniques, searching for ways to reduce costs, increase revenue, improve customer satisfaction and maximize employee productivity. The oilfield service industry is no exception.

To meet increasing demand for oil and gas, operating companies are focusing more attention on mature fields, many with declining production. Wells in these fields require intervention to maintain production levels. In addition, operators are extracting oil and gas from bypassed zones, and are discovering and developing new fields in remote locations. Mature fields generally require a large number of relatively small treatments to sustain production. For operators to realize a sufficient return on their investment, efficiency must be high, involving minimal equipment and personnel. In addition, the time required to perform the treatment must be short.

Remote locations often present logistical challenges, such as long distances between wellsites, limited transportation infrastructure, hostile climates and primitive storage conditions for chemicals and equipment. Like mature fields, these environments require a lean and efficient operation during well construction, stimulation and production.

Performing services on new and existing wells involves transporting a self-supporting array of electrical and mechanical equipment, personnel and, in many cases, chemicals to a wellsite. Depending on the application, the associated capital investment may be many millions of dollars. Traditionally, oilfield service companies have designed one set of equipment and processes that address virtually all scenarios, from small remedial treatments to massive fracturing operations. In mature fields and remote locations, such equipment often greatly exceeds the service requirements, and may be too costly and cumbersome.

To promote efficiency in remote locations and mature fields, Schlumberger has been introducing streamlined, fit-for-purpose equipment and process technology. Recent examples include the CemSTREAK rapid deployment cementer, the CT EXPRESS rapid deployment coiled tubing unit, and logging tools such as the Platform Express integrated wireline logging tool. We highlight the latest examples in this article: the high-efficiency fracturing fleet and mcrVISION low-risk propagation resistivity-while-drilling service.

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Efficient Hydraulic Fracturing in Siberia

Western Siberia, Russia’s principal oil-producing region, covers a vast area (above). The major oil fields are hundreds of miles apart and are linked by rail or primitive roads. The limited transportation infrastructure is complicated by a harsh climate. During the winter, temperatures stay below freezing, sometimes dropping as low as −50°C [−58°F]. From an oilfield services perspective, these conditions present serious logistical difficulties. Moving equipment and supplies to a wellsite may be difficult, and storage of supplies, especially chemical products, is problematic in harsh weather.

Hydraulic fracturing is one of the most complex oilfield services, involving equipment to transport and store water and chemicals, prepare the fracturing fluid, blend the fluid with proppant, pump the fluid down the well and monitor the treatment. Performing the fracturing treatment requires a team of highly trained personnel who must be in constant communication with each other. Siberian weather and complex logistics present additional obstacles that must be overcome to achieve success.

Fracturing fluids—Fracturing-fluid preparation is a vital part of the treatment and, regardless of weather conditions, must be performed safely and efficiently. The most common fracturing fluid in Siberia is a borate-crosslinked guar polymer system. Before the fracturing treatment, linear guar solution has traditionally been batch mixed in 50- to 60-m³ [315- to 377-bbl] tanks. Water taken from local sources must be heated to at least 20°C [68°F] to achieve complete polymer hydration. The hydration process can take up to 10 hours. During this period, the polymer solution is susceptible to bacterial attack and degradation; therefore, a bactericide must be added.

Batch mixing is wasteful. After the job, tank bottoms, or fluid that cannot be sucked out, remain in the tank. Tank bottoms usually represent at least 7% of the original fluid volume, and must be treated and transported to a safe disposal site. In addition, the shelf life of linear gel is at most two days. If the treatment is postponed beyond this time, the entire batch of gel may have to be discarded, usually at great expense.

A crosslinker solution is also prepared before the treatment. The solution contains borate crosslinker and additives that control the fluid pH, thereby delaying the crosslinking process. Delayed crosslinking minimizes the fluid viscosity at the surface and lowers the pump horsepower requirement. Ideally, crosslinking should occur in the well just before the fluid enters the perforations.

The crosslinker solution is continuously metered into the linear gel during the fracturing treatment. In addition, several other additives such as clay stabilizers, surfactants, fluid-loss control agents and breakers are added. The concentration of each additive must be carefully controlled; otherwise, fluid performance might be negatively affected.

High-efficiency equipment—Hydraulic fracturing requires a sophisticated fleet of electrical and mechanical equipment. In addition to the fluid tanks, a typical Siberian fracturing operation

4. Crosslink-delay agents are compounds that form a chemical complex with the crosslinker. When added to linear gel, the complex slowly disassociates and releases the crosslinker.
includes four high-pressure pump trucks, one POD programmable optimum density blender to add the crosslinker solution, other chemicals and proppant, one FracCAT fracturing computer-aided treatment carrier for job control and monitoring, one trailer for transporting chemicals, one crane and four proppant-storage and conveying systems.

Because of the transportation logistics in Siberia, a fleet of this magnitude cannot move efficiently from one location to another. Job capacity is limited to about eight jobs per month, negatively impacting efficiency. Increased oilfield activity in Siberia prompted Schlumberger engineers to search for ways to improve efficiency and enable a higher equipment-utilization rate. They had two goals: build a fracturing fleet that could address 80% of Western Siberian operations and eliminate batch mixing.

Analysis of the principal oil fields revealed that, to meet these goals, the equipment and fluid system must be able to treat wells up to 5,029 m [16,500 ft] deep, with bottomhole temperatures between 52 and 93°C [125 and 200°F] and formation permeabilities between 2 and 20 mD. Pay-zone thicknesses vary from 3 to 30 m [10 to 100 ft], and some wells have multiple pay zones. The pumping time to the perforations varies from 2.5 to 4.5 minutes; therefore, crosslink delay has to be adjustable. The job size varies from field to field, involving from about 100 to 1,100 m³ [630 to 6,920 bbl] of fluid and up to 500,000 kg [1,100,000 lbm] of proppant. The proppant size varies from 20/40-mesh to 10/14-mesh. With these specifications in mind, engineers and chemists developed streamlined fluid-preparation and blending equipment, and an improved borate-crosslinked guar fluid.

In most of the world, the PCM precision continuous mixer for fracturing has supplanted batch mixing for many years. During the fracturing treatment, the PCM unit blends water with a slurry of guar polymer in diesel fuel. The mixture circulates through hydration compartments, and linear gel discharges to the blenders and pumps. The PCM system also features liquid-additive feeders.

Originally developed for use in North America, the PCM technique was designed for treatments far larger than those performed in Siberia. The unit is too large for efficient transport on the offroad network of West Siberia. Because diesel fuel thickens at the low Siberian winter temperatures, the guar slurry used in the PCM system would be too viscous to use much of the year.

The limitations of the PCM system and slurried guar have been overcome with the advent of the GelSTREAK gel continuous mixing and hydration unit and CleanGEL hydrocarbon-free polymer-base fracturing fluids. Built on a Russian 6 x 6 truck chassis, powered by a 400-horsepower engine, the GelSTREAK vehicle is a compact PCM system that is easy to transport (above). Since CleanGEL fluids employ a dry polymer powder, fluid-handling problems during the winter months are eliminated. The absence of diesel fuel is also advantageous from an environmental point of view. An onboard, 1,810-kg [4,000-lbm] storage bin transports the polymer powder to the wellsites.

To produce a solution without lumps, the polymer powder must be completely dispersed in water. The GelSTREAK mixing system accomplishes this by using a device called an eductor. The eductor has a venturi nozzle that produces a high-velocity water stream, creating strong suction that draws the powder into the mixing chamber. The mixing zone is sufficiently turbulent to produce a homogeneous mix.
After blending in the eductor, the polymer must hydrate until the linear gel reaches its designed viscosity. Hydration requires time and fluid shearing, and the hydration rate is directly proportional to the fluid temperature. To allow sufficient hydration time, the GelSTREAK unit has a five-compartment holding tank (above). The 23.8-m³ [150-bbl] compartments are agitated, and fluid passes through them sequentially, providing first-in, first-out flow. Tank-level sensors and magnetic flowmeters monitor fluid levels and flow rates within the compartments, allowing remote hydration control.

The GelSTREAK equipment can prepare linear gel at polymer concentrations up to 6 g/L [50 lbm/1,000 galUS], at output rates from 0.95 to 6.36 m³/min [6 to 40 bbl/min]. The hydrated gel exits through the discharge manifold, and travels from the GelSTREAK unit to blending equipment in which chemical additives and proppant are introduced.

Since the early 1980s, the POD blender has been standard Schlumberger equipment for fracturing-fluid preparation. The unique feature of this blender is a programmable vortex mixer that precisely controls the proppant concentration in the fracturing fluid. The amount of proppant can be gradually ramped up during the treatment or adjusted in incremental steps. The POD blender has become more sophisticated with the passing years, incorporating an array of dry- and liquid-additive feeders, and a special system for adding fibers such as PropNET hydraulic fracturing proppant-pack additives.

During the 1990s, remote control of fracturing treatments became commonplace after the introduction of the FracCAT unit. This vehicle has an office-like booth from which
personnel control all aspects of the operation, including the POD blender. An onboard computer system records and analyzes treatment data in real time, and can transmit the information via satellite to an operator's office or regional technology center. In Western Siberia, the capabilities of the POD blender and FracCAT vehicle far exceed what is necessary to perform most fracturing treatments. Similar situations exist in areas with mature reservoirs such as Alberta, Canada, and West Texas, USA. For example, the FracCAT vehicle contains sufficient electronic equipment and space for personnel to handle massive fracturing treatments. Therefore, Schlumberger engineers designed a streamlined unit that combines the POD blender and FracCAT control booth into one vehicle—the PodSTREAK stimulation monitor and control unit (above). This combination simplifies rig-up and reduces the number of people required on location.

The PodSTREAK unit has a vortex mixer with an elevated gate and hopper system that receives proppant from a proppant storage system or sand-belt conveyor. A 1.6-m³ [10-bbl] capacity header tank, augmented by an 8 x 6 direct-driven centrifugal pump, supplies linear gel to the mixer. Additional equipment includes dry-additive screw feeders, liquid-additive metering systems and a special feeder to dispense PropNET fibers. This equipment allows continuous mixing of all chemicals required for the fracturing treatment.
The FracCAT cabin contains advanced electronics and touch screens that control the GeISTREAK unit, the POD blender, additive feeders and high-pressure triplex pumps (above). FracCAT software continuously records and analyzes treatment data, and an onboard, self-deployable dish antenna allows the InterACT real-time monitoring and data-delivery system to transmit job information to remote locations in real time. The cabin is also equipped with a fluid-sample station and a small laboratory to perform standard quality-control tests.

Advanced fluid—To take full advantage of the capabilities offered by the PodSTREAK and GeISTREAK units, Schlumberger chemists developed a simplified and robust borate-crosslinked fracturing fluid that is compatible with Siberian fluid-preparation logistics and the climate—YF100RGD crosslinked, water-base fracturing fluid. RGD is an acronym for “reduced guar, delayed,” meaning that less guar is required to attain a given fluid viscosity, and that crosslinking is delayed to reduce friction pressure during fluid placement. The fluid system increases operational efficiency by eliminating batch mixing and blending of chemicals on location, and by minimizing the number of additive streams.

CleanGEL polymer is a refined, fast-hydrating, dry guar with a higher molecular weight than conventional products. As a result, the new guar imparts higher linear and crosslinked gel viscosities. The performance improvement allows a 20% polymer-concentration reduction in YF100RGD fluids (bottom). Notice that 4.8 g/L [40 lbm/1,000 galUS] of conventional guar (green) is required to attain the same viscosity as 4.2 g/L [35 lbm/1,000 galUS] of high-yield CleanGEL guar (brown).
reduction. Using less polymer is beneficial because less filtercake is deposited on the fracture face, and the proppant pack contains less polymer residue after fluid cleanup. Both improvements help increase fracture permeability and well productivity (right). In Siberia, the typical polymer concentration range for YF100RGD fluids is between 3.0 and 4.2 g/L [25 and 35 lbm/1,000 galUS]. The traditional batch-mixed system required as much as 5.4 g/L [45 lbm/1,000 galUS].

Instead of batch mixing, the guar is continuously added to water and hydrated in the GelSTREAK unit. The resulting linear gel is then pumped to the PodSTREAK blender, where the rest of the chemicals are added. The borate crosslinker and delay agent are delivered to the wellsite as a granulated dry blend. During the job, the blend is delivered to the linear gel continuously through one of the solid-additive feeders. Eliminating crosslinker-solution preparation is safer and requires less time.

The crosslink-delay time varies with the mix-water temperature and composition (see “Oilfield Chemistry at Thermal Extremes,” page 4). Dissolved impurities can interfere with the crosslinking process. When prejob quality-control tests indicate an improper crosslink-delay time, engineers compensate by adjusting the fluid pH (right). At the wellsites, the appropriate amount of sodium hydroxide is added at the PodSTREAK blender.

The other principal YF100RGD additives, a clay stabilizer and an environmentally friendly surfactant, are also combined into one package. Stabilizers prevent clays in the producing formation from swelling and reducing permeability. Surfactants reduce the capillary pressure in the formation, improving fracturing-fluid cleanup. The stabilizer and the surfactant are liquids, and the freezing point of the mixture is –34°C [–29°F], minimizing handling problems during the Siberian winter months.

Other additive feeders on the PodSTREAK vehicle deliver materials such as encapsulated breakers and PropNET fibers. The traditional batch-mixed fracturing fluid required up to 15 additives. Because of material consolidation, the new fluid involves at most eight additives, all of which are metered continuously.

YF100RGD fracturing fluids can be used at bottomhole static temperatures between 52 and 163°C [125 and 325°F], exceeding the temperature range encountered in Siberia. With fluid-loss characteristics similar to those of other borate-crosslinked fracturing fluids, the fluids create and propagate fractures in a typical manner.


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The high-efficiency fleet (HEF), incorporating the GelSTREAK and PodSTREAK vehicles, was introduced to the Priobskoe region of Western Siberia in October 2005. The fields are operated by Sibneft-Khantos. Since then, more than 150 fracturing treatments have been performed with the new equipment and fluid. On average, the total treatment duration—including transportation to and from the wellsites, rig-up, pumping, rig-down and cleanup—has been about eight hours shorter per
well than with the traditional batch-mixing method (above). As a result, the fleet can perform up to 26 jobs per month—more than doubling the previous capacity.

Treatment success, defined as placing 100% of the proppant in the formation, increased from 60% of jobs to 88% because of the new service. This improvement can be directly attributed to improved equipment reliability, simplified fluid composition and preparation, and better control of fluid parameters while pumping. Continuous mixing saved more than 3,000 m³ [18,870 bbl] of linear gel and additives, eliminating costly chemical waste disposal. At present, one HEF operates in Siberia. Because of its success, four more are planned for the region.

**Fracturing Mature Formations in the Permian Basin**

The HEF and YF100RGD fluid are also enjoying success in North America, mainly because their capabilities are particularly suited to performing stimulation treatments in mature fields. The Permian basin in West Texas and New Mexico, USA, has been a prolific oil and gas producer for more than 85 years. Despite its age, commercially significant amounts of hydrocarbon remain in reserve; however, economics dictate that operators stimulate and recover these reserves efficiently. The PodSTREAK unit and the logistical and environmental advantages of dry guar and fewer additives are an ideal combination for this situation.

Many Permian basin operators are refracturing reservoirs, pumping fluid and proppant through existing or newly created perforations. The goal in both cases is to reestablish optimal communication between the wellbore and the producing rock. To prevent damage to old casing that may not be able to withstand the treating pressure, fracturing is often performed through tubing. The tubing also allows precise selection of individual perforations through which the fluid will be pumped.

The tubing is significantly smaller than casing; as a result, friction pressure during fracturing treatments is a major concern. Excessive friction pressure increases pump-horsepower requirements at the surface and limits the rate at which fluid can be delivered through the perforations to create and propagate a fracture. As discussed earlier, delayed crosslinking reduces friction pressure, making the YF100RGD fluid particularly well-suited for this scenario.

The first Permian basin fracturing treatments involving YF100RGD fluid and the HEF were performed at the Pinon field in Pecos County, Texas. The goal was to stimulate the gas-producing Caballos formation.

Previous treatments in the field involved 4.8 g/L [40-lbm/1000 galUS] linear guar gel or 4.2 g/L [35-lbm/1000 galUS] nondelayed borate-crosslinked guar fluid. Friction pressure was low during the linear-gel treatments. However, the fluid viscosity was insufficient to create the desired fracture geometry and well productivity. Incorporating an instant-crosslink fluid developed sufficient viscosity, but friction pressure was excessive. Therefore, the operator decided to try the new fluid system.

In one well, 3½-in. tubing was run through 9½-in. casing to a depth of 2,012 m [6,600 ft]. The formation temperature was 76.7°C [170°F] and the permeability was about 1 mD. The guar concentration in the fracturing fluid was lowered from 4.2 to 3.0 g/L, reflecting the higher efficiency of the refined dry polymer. The pump rate during the job was 7.9 m³/min [50 bbl/min], and 99,790 kg [220,000 lbm] of 20/40-mesh sand proppant were placed in the fracture.

According to ProCADE well analysis software, the cumulative gas production from the well fractured with YF100RGD fluid was 17% higher than those fractured with linear gel, and 4% higher than those fractured with instant-crosslink gel. In economic terms, up to US$ 1,800,000 more revenue was realized from this well. At this writing, 12 wells in this field have been stimulated with the high-efficiency system.

**Efficient Resistivity Logging**

Conrad and Marcel Schlumberger invented resistivity logging in 1927. Since then, resistivity measurements have been essential tools that allow operators to determine the location of hydrocarbons in subsurface formations. Induction resistivity-logging tools feature transmitter coil antennas that generate electromagnetic fields. The fields interact with the surrounding rock, giving rise to signals that indicate formation resistivity. Formation resistivity generally varies directly with water content, water salinity, temperature and the amount of conductive minerals such as clays. Most hydrocarbon-bearing formations have high resistivity. Therefore, resistivity logs can be used to identify and correlate individual rock layers, distinguish hydrocarbon-saturated rocks from water-saturated rocks and, with accompanying porosity measurements, quantify the amount of hydrocarbon in the rocks.

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**Comparison of average time required to complete high-efficiency fleet (HEF) treatments in Siberia versus the traditional method.** The HEF jobs typically save about eight hours, mainly because batch mixing and crosslinker-solution preparation are eliminated. Less equipment on location and improved equipment mobility also contribute to efficiency.

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During the past 80 years, resistivity-logging tools and interpretation techniques have become much more sophisticated. Modern tools provide high-resolution logs with corrections for invasion effects and borehole rugosity. Advanced interpretation techniques help clarify tool response in the highly deviated and horizontal wells common in many mature fields. However, in many mature fields, economics do not justify the lost-in-hole risks associated with standard wireline and LWD techniques. Therefore, operational efficiency, low cost and minimal risk are the drivers for the logging program. These challenges have spurred a significant advance in efficiency and logistics—the mcrVISION low-risk propagation resistivity-while-drilling service.

MWD tools, in which the sensors and electronics are contained in a retrievable and replaceable probe inside the drill collar, have been available for many years to provide gamma ray logs and survey measurements while drilling. This tool architecture has several benefits in environments requiring high efficiency:

- Lost-in-hole costs are lower because the probe is wireline-retrievable.
- Retrievability allows data recovery in stuck-pipe situations.
- In case of probe failure, the probe can be replaced without tripping the drillstring to surface.
- Multiple collar sizes are available for one probe, reducing the amount of equipment required to cover multiple hole sizes.
- The tool is easily transportable.

MWD tools employ steel collars. These collars do not interfere with the signals employed by gamma ray or survey measurements, but are essentially opaque to electromagnetic fields. To extend the logistical advantages of MWD-tool architecture to LWD propagation-resistivity measurements, Schlumberger engineers built a special stainless-steel collar, with slots that allow unimpeded transmission and reception of electromagnetic signals. As a result, for the first time, a resistivity tool can be seated or wireline-retrieved just like MWD tools.

The mcrVISION tool is 4.45 cm [1.75 in.] in diameter and is fully self-contained, housing antennas, electronics, memory and a battery (above left). The measurement physics and specifications are comparable to other propagation-resistivity tools such as the arcVISION Array Resistivity Compensated tool and the CDR Compensated Dual Resistivity tool. Two transmitter antennas are symmetrically positioned 83.8 cm [33 in.] above and below the midpoint of two receiver antennas that are separated by 55.9 cm [22 in.]. Each transmitter sequentially broadcasts 2-MHz and 400-kHz signals, and the receivers measure the phase shift and attenuation at each frequency. Thus, the tool provides four independent resistivity measurements with different depths of investigation. The 2-MHz measurement is best suited for high-resistivity regions, and the 400-kHz measurement is optimal for low-resistivity areas. Each phase-shift and attenuation pair is averaged to provide borehole compensation, canceling electronic drifts and borehole-rugosity effects.

At each antenna position, there are three sets of slots in the collar wall. The slots allow electromagnetic signals to pass through the collar; as a result, the collar is essentially transparent to phase-shift and attenuation-resistivity measurements.
The mcrVISION tool has been operated for more than 10,000 hours downhole, in environments that span its mechanical and operational specifications. The service is saving operational time and enabling wells to be drilled faster and begin producing sooner.

**Real-Time Resistivity Logging with Retrievable MWD**

To test the new technology, Apache Corporation ran the mcrVISION service in real time with the slim MWD system in a Gulf of Mexico well. The 24.4-cm [9.6-in.] hole was drilled with a water-based mud with a resistivity of 0.35 ohm.m.

Comparison between the LWD and wireline logs shows how well the two types of logs agree. The two blended resistivity curves from the mcrVISION tool are in excellent quantitative agreement with the wireline curves.

An example from south Texas demonstrates the operational flexibility provided by the mcrVISION-SlimPulse combination. In this 3,962-m [13,000-ft] well, the objective was to kick off from vertical through a window in the casing and build well deviation with a minimum number of trips. The assembly consisted of the mcrVISION tool collar placed above a motor and below the SlimPulse collar. The BHA was lowered to the bottom of the hole without the tools inside. Then, a wireline gyroscope was lowered through the drillstring and seated in the mcrVISION tool collar.

Drilling proceeded through the casing window, with the gyro tool providing wellbore orientation information until the effect of the casing on magnetic surveys was minimal. Engineers removed the gyro tool and pulled the BHA back inside the casing to avoid becoming stuck in the open and deviated section. By wireline, they lowered the mcrVISION-SlimPulse system and inserted it into the collars. Once the tools were seated, the wireline was removed, the BHA returned to bottom and drilling continued. Resistivity, gamma ray and survey data were transmitted to surface in real time.

After several days of drilling, the MWD tool failed. Previously, repairing this problem would have required engineers to raise the entire BHA and tools to surface. Instead, they were able to pull the BHA back to the casing, lower wireline and retrieve the resistivity tool-MWD tool combination. At the surface, engineers downloaded data from the failed tool’s memory and installed a replacement unit. They lowered the repaired combination into the well, returned the

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Comparison between LWD logs and wireline logs from a well in the Gulf of Mexico, showing excellent quantitative agreement. Track 1 contains the gamma ray measurements. Track 2 contains the resistivity measurements, the mcrVISION blended phase-shift and attenuation-resistivity curves. The 1-ft resolution wireline induction spacings are presented at depths of investigation ranging from 10 to 90 in.
Comparison of the mcrVISION and cased-hole porosity log combination with openhole wireline logs. Track 1 displays cased-hole gamma ray and openhole gamma ray measurements. Track 2 displays cased-hole density porosity and neutron porosity measurements, with an overlay of openhole density porosity and neutron porosity data. Track 3 presents an overlay of 400-kHz and 2-MHz attenuation and phase-shift mcrVISION resistivity data with the deepest wireline resistivity measurement. Track 4 displays good agreement between water saturations, \( S_w \), calculated from openhole wireline logs and those from mcrVISION/cased-hole porosity combination logs.

In another south Texas well, a mcrVISION-SlimPulse tool combination was placed above a motor in a steerable BHA. Resistivity and MWD information was transmitted in real time. During the first drilling run, the well deviation increased from vertical to 90°. The second drill run continued at 90° deviation; however, after drilling several hundred feet, the BHA became stuck 150 ft [46 m] from TD. Engineers were able to retrieve the tools with a wireline fishing system, preventing more than US$ 500,000 of lost-in-hole expense. In addition, recorded-mode data were downloaded from both tools, allowing engineers to generate a resistivity-gamma ray log.

Logging While Tripping and Cased-Hole Logging

While drilling several wells in Alberta, Canada, Schlumberger engineers combined mcrVISION resistivity logs with subsequent cased-hole porosity logs, eliminating the need for openhole wireline logs. All of the wells were about 200 m [656 ft] deep, and the wellbore diameters were 22.2 cm [8½ in.]. Each well was drilled in about 2.5 days. Performing openhole wireline resistivity logging would have added 12 hours to the process. As a result of omitting the openhole logging, the client could drill more wells in the same amount of time, significantly lowering the cost per well.

After each well was cased, the drilling rig moved to the next site. After the rig had drilled a batch of wells and moved on, Schlumberger engineers recorded cased-hole gamma ray and density-neutron porosity logs in each well. The while-drilling and cased-hole logs were then depth matched and combined to provide a petrophysical interpretation of the formation. Openhole wireline logs were run in one well to compare the mcrVISION and cased-hole-porosity log combination with openhole triple-combo wireline logs. Good agreement between the water-saturation interpretations was noted (left).

In one well, the mcrVISION tool recorded while tripping instead of while drilling. The collar was run as part of the BHA as the well was drilled. After reaching the target depth, engineers used wireline to lower the tool through the drillstring into the collar. Once the tool was seated, the wireline was removed and the drillstring was tripped out at a speed of 396 m [1,300 ft] per hour. After the tool came out of the hole, engineers downloaded the tool memory and generated a log from the recorded information. The logging-while-tripping operation added less than one hour to the operation and produced a log of the same quality as a while-drilling log.

Commitment to Efficiency

Today’s oilfield services are achieving operational efficiencies that were unthinkable yesterday, and operating companies are reaping the benefits. Increased efficiencies in equipment, processes and personnel are allowing operators to economically continue producing from mature fields and to develop new fields in remote locations.

This article presents examples of two new technologies that streamline operations during well construction, stimulation and production. The mcrVISION resistivity-while-drilling measurement and the high-efficiency fracturing fleet join a host of other time- and cost-saving services, such as the CemSTREAK cementer, the CT EXPRESS coiled tubing unit and the Platform Express logging toolstring. These technologies improve reliability and allow operators to drill, log, complete and maintain wells more efficiently and economically.

Time is money, and Schlumberger is continuing to improve efficiency in all of its business segments. Additional gains are expected as more operators test the technology currently available and push for further improvements in all aspects of oilfield operations. —EBN