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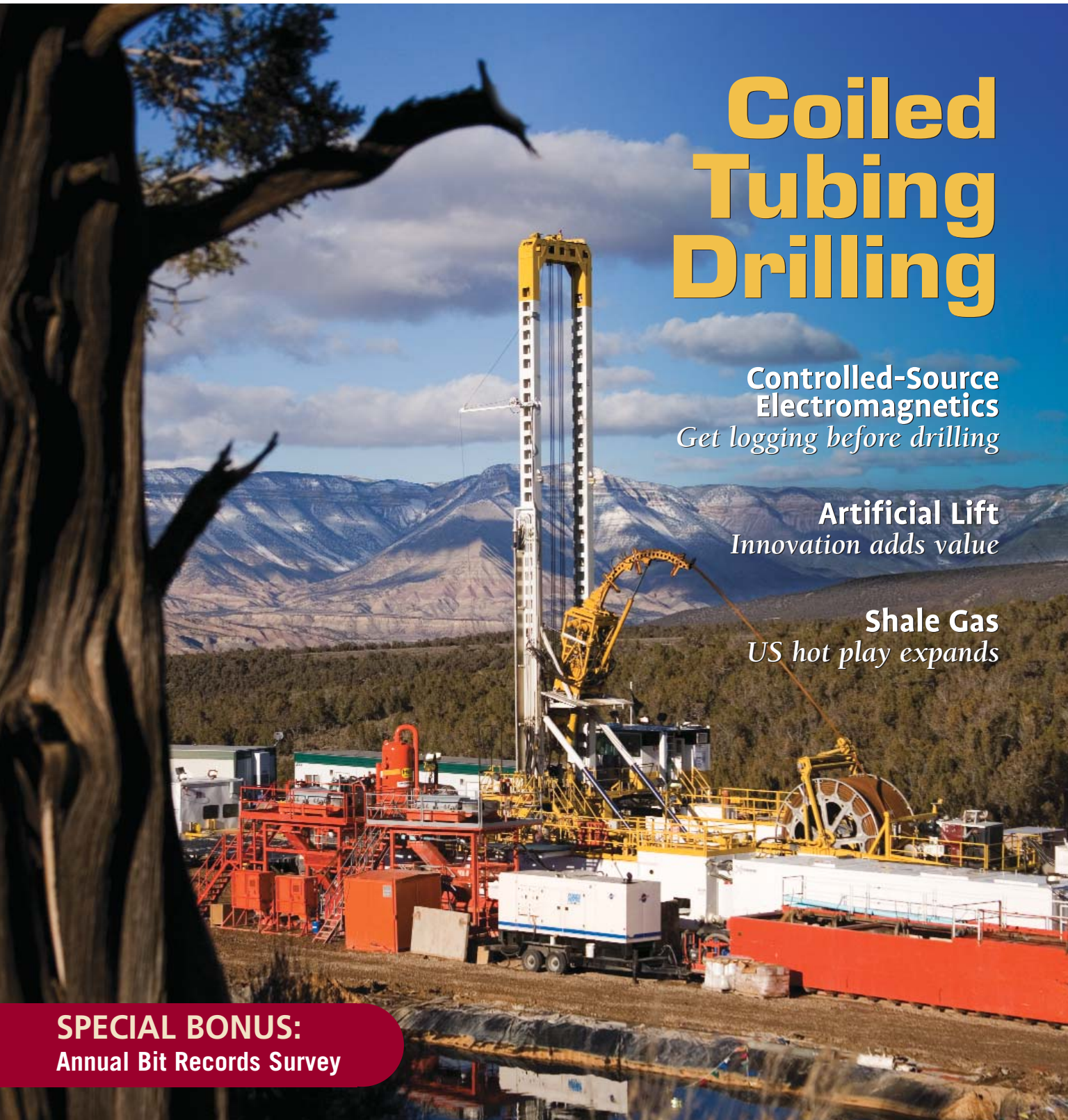

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ESPs get plug-and-play capability

A new streamlined electrical submersible pump design saves time and money.

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Installation of downhole electrical submersible pump systems (ESP) has followed a time-honored tradition for roughly 75 years. Typically pump components are lifted one at a time with the rig crane, then carefully lowered and connected to each other on the wellhead. They are topped off with motor oil and wired up to the power cable. Then they are attached to the end of the production tubing and run into the hole. The installation procedure is labor-intensive, and in some areas it is often delayed by bad weather. Even though ESPs are thought-of as being rather tough and rugged pieces of equipment, assembling them in a downpour or other inclement conditions often results in operational or reliability problems.

Getting ESPs assembled properly in the field also requires considerable skill on the part of installation personnel. A typical ESP consists of four components with additional options: the pump, including the intake that allows fluid into the pump; a protector that equalizes the pressure in the motor and provides a reservoir of motor oil; the electrical motor; and an optional gauge package containing operational monitoring sensors. Among other things, field crews must measure, calculate and install a series of shims to establish the correct spacing between the interconnecting drive shafts of the various components to properly transmit thrust. Then they must assemble the components, splice-in and seal the electrical power cable, and refill the motor and protector with dielectric motor oil. The connection and oil-filling of each protector can involve more than 20 steps, each requiring extreme care and precision on the part of the ESP technician and rig crew. Any slip-up can cause the oil to become contaminated, flange sealing surfaces to be damaged or O-rings to be pinched or cut, resulting in electrical or bearing failure.

Just performing the assembly steps for a single pump system properly can take as much as 9 hours in the field. However, if a problem like one of those mentioned above occurs, remediation is typically very expensive and requires considerable time. The penalty for ignoring or cutting corners on the established procedures is significant reduction of the pump system's service life, or even a catastrophic failure.

The solution

The new REDA Maximus ESP system from Schlumberger is specifically engineered to eliminate or drastically reduce the risks related to climatic conditions and field operator skill and make the installation inherently quicker, safer and more reliable. The new technology eliminates most critical steps in the ESP assembly/installation procedures. In a recent field operation conducted by Petrobras in its **Palo Azul** field in the jungles of Ecuador, significant savings were realized. The new streamlined procedures delivered a savings of 40% in rig time and accelerated production over conventional ESP systems.

At the heart of the new design is the integration of the protector, motor and an optional downhole gauge package into a single unit called the ProMotor unit (Figure 1). This eliminates all the human-interface motor and protector assembly steps except for the connection of the electrical cable, simultaneously improving field crew efficiency while eliminating the possibility of human error. The ESP design includes new materials and technology such as the new radial bearing design with polymer-lined bushings and an abrasion-resistant protector top bearing for added long-term reliability in adverse conditions.

The system's motors and protectors are

Figure 1. *Schematic of the ProMotor unit illustrates how integrated, factory-filled motor, protector and gauge are combined with plug-and-play power connector to eliminate weather and skill-dependent field assembly procedures. (All graphics courtesy of Schlumberger)*

Figure 2. Upper MaxJoint flange connection features sealed shaft and automatic oil communication valve, while oil-filled lower unit remains filled with pure oil and eliminates trapped air when the two are mated.

Figure 3. Plug-and-play MaxLok electrical connection saves time and eliminates human error experienced with previous field-spliced connections.

also available as individual components with bolt-on connections to allow even more flexibility in configurations than conventional technology ESPs. Two additional technological improvements are the MaxJoint flange connection and the MaxLok plug-in electrical connection. The former allows components to be directly connected with no oil servicing required at the well site, which results in a flange connection with contamination-free oil and no air bubbles being trapped in the system (Figure 2). The latter permits safe and efficient connection of the electrical cable using a combined plug-in and lock-down procedure (Figure 3).

No oil filling is required at the well site. This ensures that each component can be filled under clean factory conditions with exactly the right type of oil. Components are shipped to the field with a protective compensating shipping cap that keeps the mating surfaces and O-rings from being damaged (Figure 4). Furthermore, the compensating shipping cap contains an elastomeric diaphragm similar to a protector bag that compensates for thermal expansion and contraction of the motor oil. This maintains the integrity of the oil charge even when the equipment is exposed to large thermal cycles such as those encountered during shipping and storage in the arctic or the desert.

By eliminating the possibility of oil contamination and substantially reducing the risk of human errors, the new design results in improved reliability and extended run-life. This reduces workover costs and increases the number of days the well can stay on production without intervention. Because installation is more efficient, wells can be brought onstream faster. As an added bonus, the new ProMotor unit can be equipped with internal sensors that measure and transmit to surface real-time data such as pressure, temperature and vibration that can warn of potential problems or inefficient operation and enable the operator to manage the performance of the ESP and production from the well. In the past, ESPs in remote fields often suffered destructive failures because there was no way to monitor their performance except by observing production output, often too late to prevent damage. Operational data are encoded and transmitted up the power cable and used in a real-time monitoring and surveillance system.

It's a jungle out there

Experience on more than 300 worldwide installations to date confirms the improvements in well site efficiency, safety and reliability. These were particularly valuable in the environmentally sensitive jungles of Ecuador (Figure 5). Not only are the fields remote from the support base, but Petrobras, the operator of **Block 18,** is sensitive to being a good neighbor to the indigenous native population. Wells were pad-drilled to minimize the footprint of the production site. The same rig is used to drill,

Figure 4. Factory crew installs compensating shipping cap after topping off the unit with clean dielectric oil.

Figure 5. Located in the lush tropical forests of northeastern Ecuador, the clean, compact drillsites of Block 18 are examples of Petrobras' strict environmental stewardship.

case, perforate and complete the wells to avoid a parade of noisy, dusty vehicles and equipment running to and from the site. Besides the economic reasons stated, Petrobras wanted to be as unobtrusive as possible when drilling and equipping the wells. Cumulative production from the Palo Azul and **Pata** fields averages 40,000 b/d, most of which comes from wells equipped with ESPs.

Petrobras installed the first ESP pump system in the **Palo Azul 38** well, achieving a reduction in installation time of 40%, which resulted in a US $30,000 improvement in the well's cash flow. The company will monitor reliability over time to quantify expected long-term benefits such as reduction in maintenance costs and production uptime. E&P