Wired Composite Tubing Reduces Drilling Risk

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SINCE THE DECLINE of the cable-tool rig, well construction operations have been performed exclusively with some variation of steel tubulars. Recently a drilling system that combines composite coiled tubing technology and hydraulic workover technology has been introduced. The new system is a true leap forward in well construction and intervention technology. Key design features include:

•Reduced weight and space;

•Smaller crew sizes;

•Capability to drill difficult, complex well paths;

•Real-time, All-the-time data transmission technology;

ENHANCED DATA TRANSMISSION

Because of the unique properties of the composite pipe with embedded copper electrical conductors, the amount of downhole data transmitted to the surface is several thousand times greater than with conventional systems.

With this increased flow of data from the well there is the potential to gain a better understanding of the drilling environment. This enables the identification of potential problems before they become drilling hazards, enabling better decision making in real-time.

With this information, the wellbore can be placed more precisely within a given hydrocarbon zone. Additionally, the capability for transmitting electrical power and commands through the pipe adds increased versatility and control to the drilling process, improving well control and avoiding many hazardous conditions.

ENABLES COLLABORATIVE ENVIRONMENT

The Advanced Well Construction System (AWCS) uses state-of-the-art information technology for system control, telemetry, and real-time communication, helping enable oil companies to make rapid decisions in real time from either the drilling location or remotely.

This technology brings together formation evaluation experts, drilling engineers, geologists, and geophysicists to make better decisions in real time as the well path is being drilled. The advanced well paths can be guided with real-time updates of the earth model.

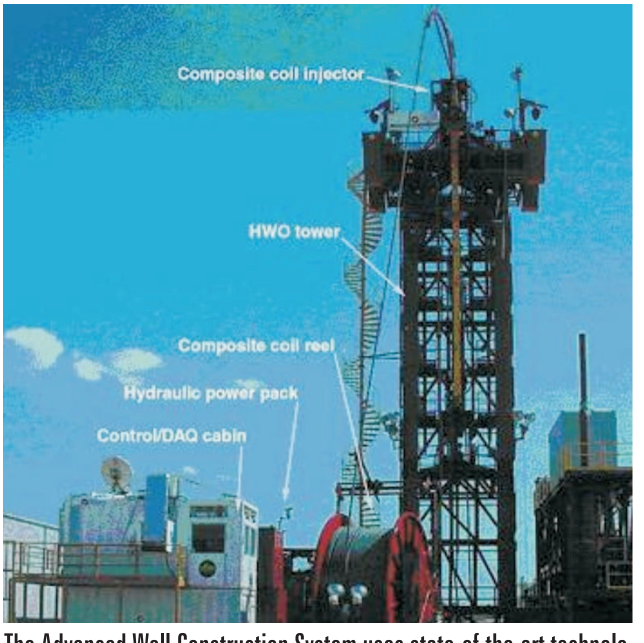
KEY ENABLING TECHNOLOGIES

The Advanced Composite Coiled Tubing (ACCT) was jointly developed by Halliburton and Fiberspar Spoolable Products. It is manufactured in a continuous coil using a tough laminate of carbon fiber and other advanced materials.

Under most drilling conditions, the pipe is nearly buoyant, which significantly reduces weight and drag compared to steel tubulars. The embedded conductors enable two-way communication with the bottom hole assembly (BHA).

With the "wired" ACCT there is no need for the BHA to contain downhole batteries, turbines, or mud pulsers. Continuously transmitting all the data to the surface for processing eliminates the need for downhole processing or memory modules.

This system significantly reduces the complexity of the BHA, which often means fewer failures.



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APPLICATIONS

With the ability to have "real-time data all the time," pump-off data that could not be seen until the end of the run can be seen immediately. Formation integrity tests (FIT) and leak-off tests (LOT) can be monitored through the PWD tool, rather than the standpipe or choke pressure gauge.

The tool equates to a downhole pressure gauge. It is no longer necessary to estimate the mud weight or the effectiveness of the gels to transmit a pressure gradient. This data provides a precise measure for the FIT and LOT, leading to better decisions made in real-time based on these tests.

The inclusion of two tension subs in the BHA is a major benefit to the driller. The tension subs help the driller monitor weight transfer from the surface to the BHA while tripping and on bottom. This data is invaluable during difficult drilling conditions such as side-tracking, pack-off, or ledging events, which can cause the BHA to become stuck.

PRESSURE SUB

The pressure sub consists of two horizontally opposed, external strain gauge devices and an internal/external differential pressure sensor. The tool is located near the bottom of the top section, above the lower tension-weight sub. Leakoff tests, formation-integrity tests, short-lived pack-off events, and borehole ballooning can be analyzed in real time. This capability increases operator confidence when determining how best to optimize drilling practices while working on bottom.

Real-time data in the conventional log has a sample rate of one every 30 to 40 seconds. When compared to the recorded data, the normal log is not a true representation of the pack-off events in time or magnitude. However, in the composite log, all of the short-lived pack-off events are observed as they occur. This information enables the operator to identify the severity of these events in real-time and make informed decisions about what actions to take.

TENSION SUBS

The tension subs use temperature-compensated strain gauges that measure both tension and compression. A major advantage is the fact that they can be used in conjunction with each other to effectively interpret potential problems, for example identifying ledges while tripping and locating them along the BHA. Remedial action can then be taken to correct the problem.

CASE STUDIES

In one case study the system anticipated pack-off events that helped avoid potential stuck pipe problems.

Pack-off detection with a conventional PWD is possible in real-time, but it requires a very experienced engineer and a certain amount of luck to capture the early short-lived interval of pack-off spikes. This difficulty is caused primarily because only sparse amounts of data can be pulsed up at any one time. Real-time sample rates often are longer than 1 per 40 seconds. A conventional PWD is adequate for trend analysis, but for short-lived and sudden events such as pack-offs, it is inadequate.

With the high data rates (2 per second) through the composite tubing in real time, the smaller short-lived pack-offs can be identified. Early identification allows the driller to anticipate the problem and take corrective action before the problem becomes severe.

When tripping in a high-angle hole, the danger of packing off is significant because of the development of cuttings beds. This is especially true when drilling a small hole (4 ¾-in. or less) with coiled tubing.

In one example, the driller slowed the tripping and flow rates to the window milled in the casing during the trip out. As the tools passed through the window, the ECD spiked when a pack-off occurred. The driller immediately reversed the tripping direction and started tripping back into the hole. This action relieved the pack-off before formation damage occurred. In addition, the downward movement of the pipe resulted in a momentary increase in the annular velocity, which helped remedy the problem.

In another pack-off event, when the pack-off occurred the pumps were shut down and the trip out was stopped. The driller reversed direction and went back in hole. This action partially cleared the pack-off and the driller continued working the pipe. With this initial success, the bend in the 3D tool was set to 1° and the flow was in increased to 90 gal/min. This action cleared the pack-off, and the trip out was resumed a short time later.

In coiled tubing operations, effective hole cleaning is one of the most challenging activities of the drilling process. The ability to anticipate the cuttings bed development in deviated wells (greater than 40°) is critical to a successful well. Best practices divide the drilling process into intervals, with circulation or short trips in between.

In one example, the tension measurements were used in conjunction with the normal surface parameters (injector tension) to develop a best practice that optimizes the drilling-interval envelope. The downhole tension data was used to measure the effective weight transfer across the BHA to the bit. At the start of the drilling interval, the effective weight on bit was 800 lb. As the volume of rock was cut, it was deposited around the lower section of the BHA, resulting in a decrease in rate of penetration and less weight on bit transferred from the upper tension measurement to the bit. This process resulted in a 400-lb decrease in transfer efficiency.

The upper tension sub did not change, but remained in a neutral position. The injector tension also remained the same until the last five minutes of drilling when the differential pressure started to fall off and the operator began to experience difficulty getting back to bottom.

The pressure data had a slight increase 0.2 lb/gal, which indicates that some cuttings were held in suspension, but the majority had formed a cuttings bed. At this point a wiper was made to move the cuttings bed back to the vertical section.