Coiled tubing provides advantages for UB operations

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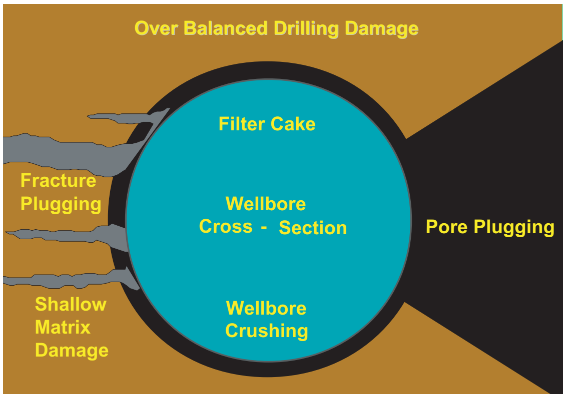
ONE OF THE primary barriers to achieving optimum production rates is damage to the reservoir that occurs during the drilling phase of well construction. This damage results from the influx of non-native fluids, chemicals and formation solids into the porosity of the formation during the drilling of the well. Naturally this damage is exacerbated when drilling horizontal wellbores where the formation nearest to the heel of the well is exposed (and thus damaged) for a considerable amount of time as compared to a vertical wellbore.



Damage to the reservoir during overbalanced drilling results from the influx of non-native fluids, chemicals and formation solids into the porosity of the formation.

For many years, air drilling has been used to overcome issues related to lost circulation of drilling fluids and differential sticking of the drillstring or bottom-hole assembly (BHA). However, this technique was not viewed as an engineered solution to overbalanced drilling damage. In fact, it was the desire to minimize or eliminate formation damage from drilling overbalanced that led to the first engineered, two-phase fluid underbalanced drilling program in 1993.

COILED TUBING DRILLING

Conventional underbalanced drilling operations use both a liquid phase and a gas phase in the drilling fluid to reduce hydrostatic head and achieve underbalanced conditions in the wellbore. This requires the use of floats installed within a jointed-pipe drill string with everything above the float being displaced to a single-phase fluid (liquid phase) prior to making a connection. Since circulation is suspended during the connection, the gas and liquid phases separate in the wellbore (with the gas rising and the liquid falling out), resulting in pressure surges against the reservoir. Additionally, when pumping is halted, a cuttings bed is formed. As drilling operations resume after the connection is made and pipe rotation begins, this cuttings bed can be gradually ground into the well bore face.

Alternatively, coiled tubing is an excellent choice for conducting underbalanced drilling due to its continuous nature. Since there are no connections to be made with coiled tubing, bottom-hole pressure can be kept consistent with no forced surging on the reservoir.

If the wellbore hydraulics are properly designed, a cuttings bed can be avoided. With coiled tubing drilling, the underbalanced state of the well becomes a steady-state flow regime (due to continuous circulation of the drilling fluid) and thus a “true” underbalanced scenario is reached.

REDUCED COSTS

Reducing drilling costs by increasing the average rate of penetration (ROP) also takes advantage of the continuous nature of coiled tubing. This is especially important where high instantaneous ROP occurs and thus is why coiled tubing drilling (CTD) is becoming very popular in the shallow gas fields of southeastern Alberta where ROP can be in the order of 1,500 ft/ hour. With a conventional jointed-pipe rig, most of the operational time is taken up with making connections as opposed to drilling the wellbore. This continuous pipe advantage of CTD translates to reduced operational costs (whether drilling over- or underbalanced).

These reduced running costs can make a significant difference in project economics. With the added benefit of eliminating formation damage (drilling underbalanced) and its inherently superior multi-lateral capability, CTD is the technology to watch for drilling in coal bed methane, for example.

LIMITATIONS

But, as with any system that offers advantages over another, drilling with coiled tubing has its limitations. If wellbore stability problems develop during drilling, coiled tubing cannot be rotated. Also, a coiled tubing string simply cannot withstand the physical abuse that conventional drill collars and drill pipe can take if jarring is required to release a BHA that is stuck in the hole.

CTD IN EUROPE

A recent underbalanced CTD project in Europe entailed drilling a 500-meter horizontal section in each of two wells into a naturally fractured carbonate formation. Bottom-hole pressure was 4,800 psi and BHT was 220° F (105° C). The reservoir portion of the wells would be drilled underbalanced using a mixture of KCl brine (8% -16%) and nitrogen.

The wells were drilled underbalanced because of the massive volumes of drilling fluid lost when natural fractures are encountered in an overbalanced drilling scenario. When drilling underbalanced, drilling can continue from the time the first fracture is encountered through to subsequent fractures, producing better wells and allowing good evaluation of the formation over a broader area.

The operator formed an internal team to manage all aspects of the project. Substantial pre-planning and subsequent team exercises included the use of a UBD simulator and a Drilling the Well on Paper exercise. These steps were used to determine personnel competencies and interaction and to identify possible technical and/or HSE exposures. As a result, risks and exposures were eliminated or reduced to satisfactory levels.

Personnel from five nations where mobilized in support of the project. A coiled tubing reel and drilling structure, surface separation systems, two-phase pumping equipment and a drilling BHA including positive displacement motors were mobilized by two principal contractors in support of the project.

PRE-PLANNING AND TRAINING

Pre-planning, a mock rig-up exercise and on-site personnel training were huge factors in the success of this project. Planning covered everything involved from hazard identification to detailed drilling procedures. The mock rig-up was used to bring together personnel from two BJ Services regional operations from Canada (responsible for the drilling BHA and underbalanced engineering) and The Netherlands (to supply the coiled tubing and pumping equipment).

The rig-up allowed operational personnel to become familiar with the specific equipment on site, practice rig-up procedures and determine any operational issues with the system. On-site training helped develop the close teamwork required for underbalanced drilling as all aspects of the operations were simulated, from high-pressure (4,000 psi) wellhead deployment and retrieval of the drilling BHA to a high-pressure gas kick to be handled by the surface separation system. This training was especially beneficial to those personnel unfamiliar with underbalanced drilling as it provided thorough understanding of the complete operation.

DRILLING OPERATIONS

Natural gas production began soon after drilling commenced on the first well. As each subsequent fracture was encountered the gas rate increased accordingly. There was sufficient natural gas influx during drilling to allow nitrogen gas pumping to cease and keep the well underbalanced.

The operator decided to terminate the underbalanced drilling on Well #1 after 580 feet (176m) had been drilled due to unexpectedly high gas rates and accumulated operational costs approaching budget allocation for the well. All drilling operations and deployments were performed with high surface gas rates and high (4,000 psi) wellhead pressure.

Drilling of Well #2 was completed in eight days during which two lateral sections were drilled, 1,720 ft and 1,120 ft (524 m and 342 m), respectively. During drilling and deployment operations, Well #2 flowed gas that contained 500-1,500 ppm of hydrogen sulfide (H_2S). All deployments and drilling were performed in a live well environment with returns handled through the surface separation plant.

In total, roughly 3,440 feet (1,048 meters) of reservoir were drilled with no accidents or incidents during operations where approximately 70 individuals from five different countries were involved in various aspects of the underbalanced operations.

ROLES FOR DIFFERENT RIGS

Although many of the grass roots coiled tubing drilling rigs (those rig used to drill wells from or near the surface) are designed to handle casing and completion strings, the CT rigs that finish wells, i.e. drill the reservoir section underbalanced, generally are not equipped for such loads. When these CTD units are to be used, a conventional drilling rig is used to drill and set casing in the top-hole section and to drill and case the build section to or near the target zone. This portion of the well construction process is conducted overbalanced since the target is not penetrated to any significant degree.

When the target zone is reached, the conventional drilling rig is demobilized and the CTD unit is mobilized to the wellsite to resume drilling operations in an underbalanced fashion. By using the conventional, jointed-pipe drilling rig for the top-hole section and a CTD unit for the target section of the well bore, each respective unit is employed doing what it is designed to do best.

CTD: THE FUTURE

Coiled tubing drilling technology is continually improving to meet the increasing demand for true underbalanced drilling of horizontal targets. Operators are constantly seeking the best return for their investment dollar while trying to maximize results from their drilling programs. Several concepts for reducing both capital and operating costs have been proposed in recent years to achieve these objectives.

Slim-hole drilling and short radius drain-hole drilling, for example, have been suggested to reduce well costs. Entering existing wellbores (both on and offshore) is an established and growing application for coiled tubing drilling. The renewed focus on coal bed methane reserves using CTD's advantages in multi-lateral and underbalanced drilling is expected to grow as well. The capabilities of the grass roots CTD units are expanding, moving these rigs into operational arenas beyond the traditional shallow gas markets, and this evolution will continue.

The primary drivers behind coiled tubing drilling technology are economic. In Alaska, the largest overbalanced CTD market to-date, CTD units are much less costly than a fully equipped North Slope drilling rig. As CTD technology spreads, it will likely be employed to minimize or eliminate reservoir damage from drilling (via underbalanced drilling) and/or to reduce drilling costs by drilling wells faster, both through high ROPs and by eliminating time/cost that is otherwise lost to making connections (with jointed pipe). In addition, new markets are opening up to take advantage of the environmental and logistical benefits of the smaller-footprint CTD units and their ability to efficiently drill multi-laterals and more effectively drain reservoirs. ■