Sidetracking with SET overcomes challenges

Greg Noel, Enventure Global Technology

WHEN SIDETRACKING A well, an operator will lose one entire casing size, reducing the ID in the target zone, decreasing production and challenging the economic viability of the project. Solid expandable tubulars (SET) are becoming a viable means to overcome certain challenges to existing operations and to offset some of the higher expense. Recent technological breakthroughs, developing and deploying modified expandable tubulars and making use of the latest advances in multilateral window milling systems have enabled SET technology to become a reliable method to overcome the unique challenges faced by older operations.

The combination of SET technology and multilateral window milling systems allows operators to slim their wells, resulting in reduced capital outlay, minimized environmental impact, maximized reservoir potential and a superior rate of return.

The most obvious advantage is larger ID in the target zone, thereby increasing production. More importantly, the two complimentary applications have the potential to significantly reduce capital expenditures for the life of a field. These savings are realized in the productivity enhancements in fields where the operator has already capitalized the exploration and development outlay.

SET TECHNOLOGY

There are presently two distinct situations where solid expandable systems would prove both beneficial and economically viable. One such case is field development using SET where the operator chooses to drill and produce a well with solid expandables from the outset. Another situation involves the recompletion of wells in which the original wellbore is no longer meeting productivity expectations, or it is identified that optimal drainage could be achieved by having the wellbore in another location of the reservoir. A well can be recompleted as a larger producer through a casing sidetrack using SET technology.

BUSINESS CASES

Two applications of SET in conjunction with side-tracking technology are in older platforms with no remaining template slots and deepwater recompletions on a tension-leg platform through a riser. In the former case, the only economically-feasible method to reactivate a field is to re-enter existing wells using SET to preserve a larger ID. In the latter scenario, SET can be run through a milled casing window using the smaller production riser. This can save expensive rig time and reduce nonproductive time to pull the production riser, install a larger drilling riser to perform the recompletion and then rerun the production riser.

A combination of SET technology and multilateral window milling systems can result in slimmer wells, reduced CAPEX and minimal environmental impact.

A common perception is that big bore completions deliver high rates above and beyond that of conventional completions. In these cases, a well's outflow performance increases as a result of decreased pressure drop in the larger diameter tubing. The problem occurs when the size of the production casing in many of the wells limits the size of tubing that can be used to improve productivity. More generally, the size of any of the casing strings set in a well limits the size of the next string and ultimately limits the size of the completion string. This situation constrains the internal diameter available for production or injection.

Solid expandable tubulars, however, provide the ability to turn a tubing-constrained completion into a big bore producer whether incorporated in the original well plan or used as a result of a challenge encountered during drilling. For example, performance modeling by one operator on a well with 7-in. tubing in 9 ⅝-in. production casing showed only a 10% increase in well deliverability from a tubing change-out completion to 7 ⅝-in. tubing, the largest size tubing that can be run. Alternatively, recompletion using 7 ⅝-in. solid expandable tubulars showed a 40-50% increase in well deliverability and a 50-100% increase in production. A successful field pilot test of a solid expandable tubular workover by this operator proved the viability of the application.

Operators also regularly deploy recompletion technology in wells producing at less-than-optimal performance or to expand the drainage reach of individual wells. Operators recognize the many benefits the SET technology offers, which have been driven by slot availability on aging platforms, better reliability and feasibility of casing whipstock and milling systems, and increased reservoir knowledge.

These two technologies used in concert present the potential application of larger multi-lateral sidetracks. The combined benefits of these applications include increased productivity using wells and facilities already in place, and the availability of a larger ID for recompletion and stimulation.

DESIGN CHALLENGES

A natural progression led to SET being introduced into deviated wells. The technology has been proven to work in sidetracked wells, and tests were positive when solid expandable tubulars were run through specially-cut casing windows.

However, certain mechanical challenges had to be overcome. A previous unsuccessful installation of SET in a deviated well with high dogleg severity provided insight into some of the mechanics that affect the successful deployment. A contributing factor of the unsuccessful installation was determined to be damage to a connection, and a solution was implemented.

After the potential risks were mitigated, attention was turned to the specific parameters affecting a successful SET installation through a casing-sidetracked well. Those parameters included dogleg severity; casing material; whipstock material; length and width of the casing window; quality of the milled window; and stiffness of the solid expandable tubular running assembly.

Subsequent to the unsuccessful installation in a deviated well, solid expandable tubulars could still be run in a casing-sidetracked well, but preparation requirements called for milling a 100 ft section. In some cases, because of time requirements, this option could be uneconomic.

ENGINEERING AND TESTING

One of the most influential factors affecting the successful implementation of SET through a milled casing window is the physical characteristics of the window itself. A way to mitigate or eliminate this problem was a necessity.

Recent advancements in multilateral technology provided the key. These advancements resulted in window milling systems that produce an enhanced window in which nearly the total window length is full gauge. Benefits of a longer full-gauge window include trouble-free entries and re-entries through the window for drilling and completion of laterals; ideal parameters for short radius departure; sidetracking in hard formation without drilling a rat hole; compensation for any mismatch in depth tally calculations; and eliminating problems associated with a skewed window.

It was predicted that coupling newer multilateral technology with SET technology could offer a viable and economical method of exploiting the benefits available from big bore multilateral sidetrack completions. A series of lab tests, surface tests and surface simulation tests were devised. A field trial was performed to prove the viability of the technology application. Throughout the project, weaknesses were identified, solutions were implemented and lessons learned in each test were carried into the design of subsequent tests to improve the product.

Lab Tests. Following the early unsuccessful installation of SET system in a deviated well, it was determined that damaged connections was a major factor contributing to the failure. The damage sustained in running the casing string, coupled with bending stresses induced in the damaged connections by the deviated well trajectory, resulted in the loss of pressure integrity when the connection was subjected to the expansion forces. A means of enhancing the connection was developed and data was collected to determine the maximum dogleg in which protected connections could be successfully expanded.

Surface Test. A surface test was performed with a string of several joints of solid expandable casing snaked around offset spikes driven into the ground. This arrangement roughly simulated the bending stresses that would be induced in a deviated/doglegged well. The casing string was then successfully expanded and data was collected from this surface test to provide a basis for further simulation testing.

Surface Simulation Tests. Two surface simulation tests were designed and conducted in cooperation with specialists in multilateral technology. These tests simulated actual operating conditions by using a horizontal cement test block with a joint of base casing cemented within the block. A window was milled in the base casing and the lateral was drilled by a different commercial milling system in each test. Solid expandable tubular casing was then run and expanded and data was collected for post-test analysis.

FIELD TRIAL

A field trial under actual operating conditions was performed in Starr County, Texas, in a flowing gas producer that was drilled and completed with a perfect safety record.

A 7 ⅝-in. x 9 ⅝-in. SET openhole liner system was expanded through a window cut by a commercial enhanced window milling system. The window was cut from 6,741 ft to 6,756 ft in 9 ⅝-in. 47 lb/ft casing. An 8 ½-in. x 9 ⅞-in. bi-center bit was used to drill to a total depth of 7,530 ft. Once the bit left the window, it was allowed to pendulum itself back to vertical.

A logging program was run at TD consisting of a 4-arm caliper, repeat fluid test (RFT), and an ultrasonic inspection test (USIT). The USIT was run to evaluate the milled window.

Prior to running the SET, an 8.379-in. dummy drift launcher was run through the window to insure that the launcher and the 7 ⅝-in. expandable casing would be able to traverse the dogleg resulting from the window exit. The maximum dogleg severity was calculated to be 27°. The drill pipe came in contact with the top side of the window when the dummy drift was 15 ft below the window. It was necessary to rotate the dummy drift to open up the dogleg section in order to freely pass the dummy through that section of the hole.

The 876 ft of 7 ⅝-in. x 9 ⅝-in. SET string was run to a TD of 7,530 ft. and cemented prior to expansion, which was initiated at 4,000 psi. The unconstrained pipe expanded at 2,200 psi. The connection expanded at 3,800 psi. No significant pressure changes were seen as the cone passed through the casing window. The rams of the BOP were then closed and the liner was tested to 2,000 psi for 20 minutes.

The highlight of the field test was that 876 ft of 7 ⅝-in. x 9 ⅝-in. solid expandable tubulars and 23 connectors were expanded through a casing window and tested successfully to 2,000 psi for 20 minutes. This was the second successful expansion of a casing string through a milled window.

COMMERCIAL APPLICATIONS

Nine commercial jobs have been deployed successfully since 2002 with three different companies in three different regions of the world: the Gulf of Mexico, the Middle East, and the United Kingdom. The sizes of the expandable casing were 7 ⅝-in. x 9 ⅝-in.; 6-in. x 7 5/8-in.; and 5 ½-in. x 7-in.

By using SET, the operators were able to retain the capital assets that are already in the ground with minimal ID reduction.