

Deeper, more deviated wells push development of smart drill stem rotary shouldered connections

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THE CONTINUOUS developments in oil and gas drilling operations have resulted in a significant increase in the application of extended-reach wells and horizontal drilling procedures as well as HPHT downhole conditions. These deeper and more deviated wells require the use of a drill string that has both higher torsional yield strength drill pipe body and greater torque capacity tool joints than is afforded by standard API connections.

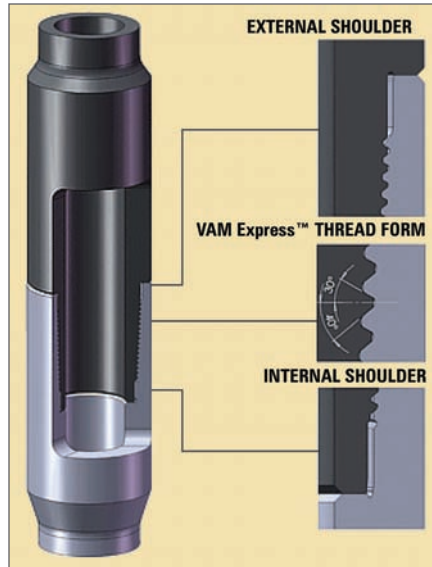
Also, the combination of complex well profiles with HPHT conditions downhole can lead to even higher stresses on the drill string, therefore requiring greater safety margins in the drill string design.

Also, due to the high financial risks associated with drilling operations today, oil and gas companies are continuously looking at mitigating drilling risks and reducing total drilling costs. This involves optimizing drilling programs and drilling efficiency.

Improved efficiency is generally associated with higher rates of penetration (ROP) and lower nonproductive time (NPT). An accurate drill string selection prior to operations planning can help achieve these targets. A number of factors related to the drill string assembly can be considered to optimize drilling performance. Among them are:

- Pipe and tool joint dimensions for hydraulics efficiency;
- Pipe yield strength for torque and drag optimization;
- Pipe body, weld and connection mechanical properties for tension and torsion capacity;
- Other drill pipe design related features for fatigue resistance, serviceability and operating cost optimization.

New OD/ID ratios used on drill pipe, dictated by hydraulics requirements, have required new thread designs called "premium connections." Recent high torque tool joint connection designs have been focused on highest mechanical performance capabilities, generally to the detriment of the drill pipe's ability to be run and its durability, compared



VAM Drilling's smart rotary shoulder connection includes a proprietary thread profile and high-performance double shoulder design to produce a rugged, high-torque connection.

with API connections. Starting from this, VAM Drilling has developed a new smart rotary shoulder connection that provides optimum operational performance to extreme drilling conditions, with minimum impact to conventional rig tools, standard handling procedures and minimum service cost.

DESIGN, QUALIFICATION

This premium connection incorporates a proprietary thread profile and high-

performance double shoulder design producing a rugged high-torque connection. The primary torque shoulder provides initial seal and pre-load during make-up to full recommended torque and the secondary torque shoulder provides high torque capacity.

The thread form features a large, rounded stab crest and a laid-down stab flank, which allow easy stabbing of the connection. A back bevelled crest reduces the chance of wedging the thread and increases the freedom of movement, allowing easy connection make-up. The elliptical root increases resistance to rotational-induced bending fatigue.

The design has been subjected to rigorous engineering analysis. These include full FEA modeling for pure torque loads and combined torque and tension loads.

During the final stages of the connection development, the design was subjected to live testing in Well Heather 1-5 in the following conditions:

- Depth: 18,150 ft
- Hole: 6 ½ in.
- Section profile: Straight
- Rig equipment: Varco top drive and Iron Roughneck
- Top drive torque: Average 3,300 ft-lbs
- Top drive RPM: 40



VAM Express allows for quick make-up, with 5-6 turns from stab-in to full make-up.

- Drill pipe: 4 inch, 14-lb S135 pipe, 4 7/8-in. OD x 2 13/16-in. ID tool joints, with VAM Express VX 39
- Typical bottomhole assembly: Drill bit, turbine, stabilizer, 14 drill collars, jars, 3 drill collars, 6 HW
- Thread compound: Bestolife Copper Supreme Special Blend
- Typical average rate of penetration: 3 to 4 ft/hr

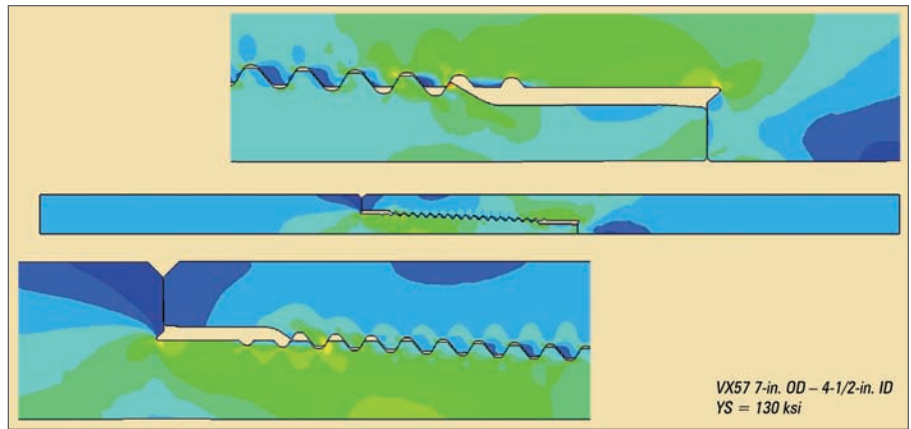
RESULTS

- Consistent connection running.
- No connection reject related to stabbing, make-up or drilling operations.
- Trip time in line with expectations.

PERFORMANCES

High Torque: VAM Express has torsional strength that provides torque capability 1.5 to 2 times that of API connections. It allows change of OD/ID for improved hydraulic performance.

Greater safety margins: High torque to yield resistance, progressive failure mode if overtorqued, optimized behavior for HPHT drilling conditions.



FEA modeling used in the development of VAM Express.

Quick rig make-up: 5-6 turns from stab-in to full make-up, similar to API connections, with trip-time savings up to 16% better than other high-performance connections.

Connection	Turns stabbed to shouldered
API NC38	5.5
VAM Express	5.7
Other Premium Connections	Up to 13

Extended service life: VAM Express has been designed to minimize damage risk during use and recut tong loss when a recut is required. Specifically, the connection provides:

- Limited stabbing risk: enhanced clearance between box counterbore and pin nose.
- Reduced wedging risk on threads.
- Improved pin nose durability.
- Improved drill string fatigue life: the patented design includes an elliptical thread root that increases the connection's resistance to rotational bending fatigue.

FIELD-PROVEN

Improvements in terms of ease of run and service life of the product have been experienced during recent drilling operations in Indonesia, with VX 39 drill pipe rented by Weatherford International to Chevron. The drill string was composed with 500 joints of drill pipe and 30 joints of heavy-weight drill pipe. It was used by Chevron between May and October 2006, which gives a 6-month period of analysis.

Seven 6 1/8-in. hole sections were drilled with this pipe at an average depth of

11,500 ft. Deviation was between 40° to 70°; average bottomhole temperature was 125°C; nominal pressure and mud weight 9.6 ppg.

“The use of this drill pipe solved excessive ECD problems experienced with another brand of drill pipe,” Chevron said. “The prime reason for Chevron hiring this string of 4-in. VX39 was to improve our mud ECD and cuttings transport. We had stuck 3 bottomhole assemblies (recovered only one) before switching to 4-in. VX39. After the switch, we enjoyed lower ECDs, better hole-cleaning and equal or faster trip times,” they added.

“At the end of the campaign, there were 17 connections that required repair (9 pins and 8 boxes) due to sea air corrosion,” said Dale Potter, Weatherford sales manager – Far East, based in Indonesia.

This drill string is currently being used in Thailand by Chevron for a 6-month period, during which improved hydraulic characteristics and low repair rates will be re-confirmed.

CONCLUSION

This new tool joint connection has shown significant improvements in both mechanical performance and operating costs:

- Torque capability up to two times that of API connections, resulting in optimum resistance in harsh environments;
- Significant trip time savings, up to 16% compared with competing products. This translates into thousands of dollars saved for one deep offshore well today;
- Extended service life and reduced operating cost as a result of fewer recuts and less refacing operations. ♪