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Hydril tubular connection finds perfect harmony with Weatherford MPD system

IN 2004 AND 2005, Unocal teamed up with Weatherford International and Hydril on a managed pressure drilling program in the Gulf of Mexico. For the first time, the operator decided to couple Weatherford's MPD system with a tubing connection. The combination, according to Hydril Technical Services Manager **Ben Kelly III**, was a technological success that showcased the potential of the two systems working together.

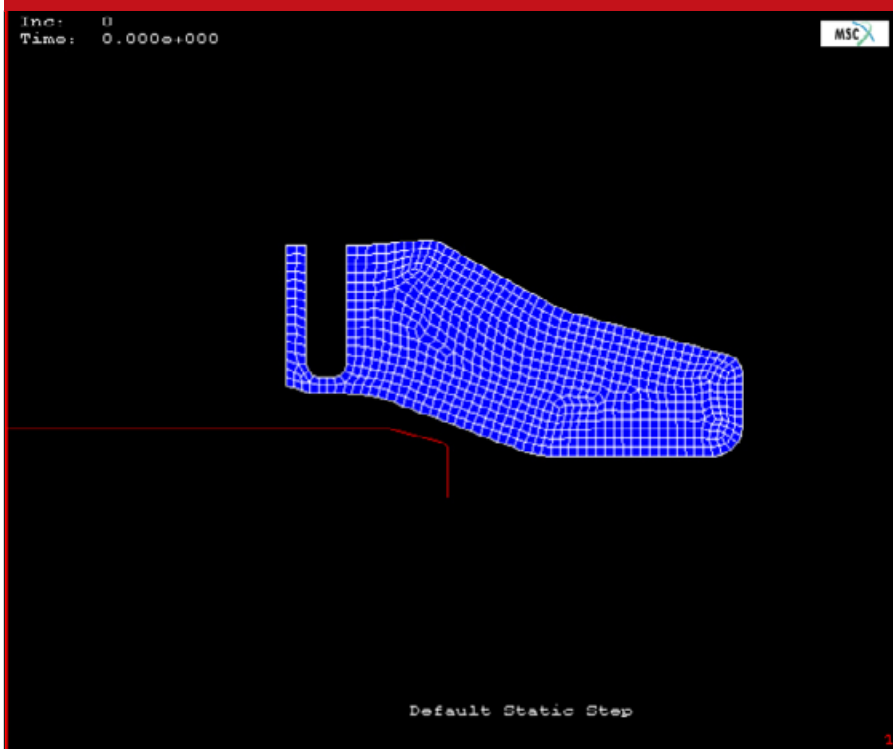
PROJECT BACKGROUND

The drilling was targeted for the East Breaks 160 Cerveza Platform, which was set in 1981 and had 25 wells. The platform is located in 940 ft of water and has two 20-slot wellbays. The Pride 1502 Platform Rig was used to complete the project. The program planned for a total of eight wells 105 miles from the Galveston shore base. In the end, however, only 1 new well was drilled, followed by 2 sidetracks.

Due to historical drilling challenges associated with wells in the area, Unocal looked at managed pressure drilling as a way for re-entry. Some of the benefit of MPD considered were:

- Narrow pore pressure and fracture gradient windows;
- High permeability zones;
- More precise control over wellbore pressures;
- Ability to lighten the mud in zones where lost circulation is expected;
- Allows better control of wellbore stability; and
- When conventional practice of mud-weight is greater than pore pressure, lost circulation occurs when the pumps are turned on at planned circulating rates. "As soon as the pumps are started, there's a pressure spike at the bit, which

Web-exclusive content: *Click on image to view animation.*



This FEA animation models 18-degrees and 30-degrees on a tooljoint, showing it going through the stripping rubber at different stages. This was the marrying of the Weatherford Model 7100 MPD system with Hydril's 522 tubing connection. The FEA show that these two systems can work together in harmony. *Provided Courtesy of Weatherford International.*

translates into bottomhole pressure. That means you may be exceeding the fracture gradient of the formation being drilled into," Mr Kelly explained.

When the initial wells were drilled, Unocal encountered many challenges, including wellbore ballooning and losses, stuck pipe, hole-cleaning issues, difficulty obtaining log data and, of course, logistics and deck space limitation due to it being a remote platform. Unocal took those lessons learned and sought to use the innovations of MPD and tubular technology to improve its new drilling campaign.

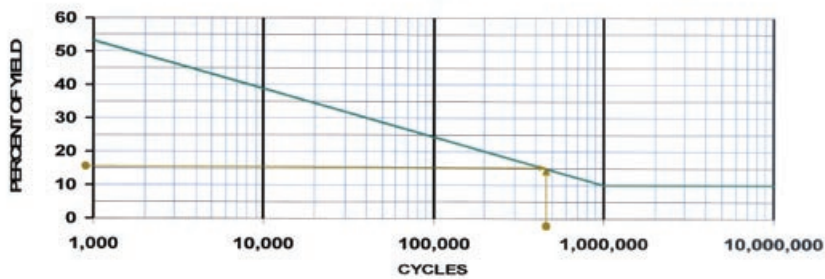
Once Unocal decided on using MPD technology, it had to pick a managed pressure drilling system. The system chosen was a rotating head system. Weatherford's Model 7100 was utilized. It was 5 ft-tall and could handle up to 6 ft-in. tooljoints, with dual sealing elements and a working pressure of about 2,500 psi while rotating.

PICKING THE CONNECTION

After the MPD system was selected, the connection had to be chosen. Unocal began reviewing more than a dozen connections, most of them conventional drill-pipe configurations. Keeping in mind the

Fatigue Life Estimation Curve

Hydril Series 500 Tubing S-N Curve for Bending



$$\theta = 12 \text{ deg} / 100 \text{ feet}$$

$$D = 4.500 \text{ in.}$$

$$SF = 1.5$$

$$\sigma_Y = 110,000 \text{ psi}$$

$$\sigma = 211 \times 4.500 \times 12 = 11400 \text{ psi}$$

$$\sigma D = (11400 \times 1.5) / 110,000 = 15\%$$

$$15\% \text{ on chart} = 480,000 \text{ cycles}$$

historical difficulties in drilling the East Break wells, a connection that would allow much improved hydraulics would be required. The companies narrowed their field down to three choices:

- 3 fi-in. 13.30-lb S-135 NC38;
- 4-in. 14.00-lb S-135 NC40;
- 4 fi-in. 15.50-lb P-110 Hydril Type 533, the one that was ultimately chosen.

Three other criteria were considered in the selection: The connection had to be readily available, usable on all 8 planned wells, and Unocal wanted to use the connection as a completion string after workover operations were completed.

Hydril already had several hundred runs in Mexico where the Type 533 connection is used as a drillstring, then buried on every third well as a completion string after its fatigue life was drilled out on the first two wells. "We've had absolutely no problems with that," Mr Kelly said.

Based on the above criteria, the companies compared their top three candidates (see Table 1). Because the 533's tubing joints are cut on an integral IEU upset, the strength of the tubing is maintained so that it has the same strength all the way through.

Mr Kelly pointed out that the tubular connection can provide a much larger ID than its competition along with a smaller OD. That would come in handy because the companies knew that equivalent circulating densities "were going to give them a lot of challenges," he said, and one of the main ways to improve ECDs is to have a large ID and a smaller OD.

He also emphasized the "benign failure" aspect of the connection. Whereas pins tend to twist off on rotary shoulder connections, the Wedge Thread connection will plastically deform the box, giving a warning before it fails. This will be seen on inspection during tripping operations instead of having to fish downhole. The connection also did not require any hard banding, he pointed out.

Benefits also were identified with the Wedge Thread used with the 533 connection. Aside from high torsional yield strengths and good fatigue characteristics, a smooth bore for cementing and metal-to-metal seal for drill stem testing (DST) and completion, it also had 100 percent pipe-body tension, compression, burst and collapse, which meant that the connection was not the weak link. It's as strong as the pipe body.

Based on all considerations, Unocal selected the Hydril connection, which had never been used with the Weatherford Model 7100 MPD system before. It turned out to be a great combination, Mr Kelly said.

THE DRILLING

Although 8 wells were originally planned, the project ended up drilling 1 new well and 2 sidetracks.

On the new well, workers drilled out to their first target using Weatherford's MPD system, set a 7 fi-in. liner and cemented it in place. They then drilled out the float collar and the shoe before drilling out to the second target and setting a 5 fi-in. expandable liner. Workers cleaned out the hole and circulated completion

fluid. Then they perforated using tubing-conveyed perforating (TCP) and flowed the well back. The zone of interest was gravel-packed and frac-packed. On this well, a total of 20 full trips and 27 short trips were made on the drill string.

On the next well, a sidetrack, workers picked up and ran a bit and scraper to the bottom before setting a sump packer and whipstock and milling out a window. They drilled out to the target zone and set a 7 5/8-in. liner. A float collar and shoe were drilled out and cemented before drilling to the second target. A 5 fi-in. liner was set, a scraper was run, and completion fluid displaced. They then again perforated the zone of interest with TCP and gravel-packed and frac-packed the zone of interest. A total of 17 full trips and 18 additional short trips were made on the same string.

So far, if all this sounds a little mundane, then you've gotten the point that Mr Kelly is trying to convey. "I want to emphasize that no surprises happened. The combination of the connection and the MPD system did not cause any problems at all. They worked as anticipated together," he said.

On the second sidetrack well, they ran in with bit and scraper, set whipstock and milled out the window. They made a clean-out trip and ran in to dress the window. At this point, there was an occurrence of stuck pipe. After its retrieval, they dressed the window and drilled out to the target zone. A 5-in. liner was run, but the liner stuck.

At this point, the project was terminated. A bridge plug was set, and they plugged and abandoned the well. For this third well, a total of 12 full trips and 15 short trips were made.

TOTAL USAGE SUMMARY

On the total usage summary of the string, a total of 49 full trips and 60 short trips were made. This equates to about 109 make and breaks on each connection. Operational extremes were:

- 10,000-lb. weight on the bottom (WOB) setting packers
- 80 kips over pull with jars during fishing
- 35 kips set down during fishing
- 13,000 ft-lbs maximum torque during drilling.

Table 1: Comparing the 3 connection candidates

| Specification | NC38 IF (S) | Type 533 | NC40 FH (S) |
|--------------------------|---------------|---------------|---------------|
| Wall Thickness | 0.368 in. | 0.337 in. | 0.330 in. |
| Pipe ID | 2.764 in. | 3.826 in. | 3.340 in. |
| Drift | 2.000 in. | 3.701 in. | 1.875 in. |
| Box OD | 5.000 in. | 4.992 in. | 5.500 in. |
| Pin OD | 5.000 in. | 4.868 in. | 5.500 in. |
| Box and Pin ID | 2.125 in. | 3.776 in. | 2.000 in. |
| Minimum Make-up Torque | 13,000 ft-lbs | 5,800 ft-lbs | 18,000 ft-lbs |
| Yield Torque | 18,100 ft-lbs | 29,000 ft-lbs | 36,000 ft-lbs |
| Pipe Body Yield Strength | 489 kips | 485 kips | 515 kips |
| Collapse Pressure | 12,000 psi | 14,340 psi | 20,140 psi |
| Internal Yield Pressure | 13,800 psi | 14,420 psi | 19,490 psi |
| Hard banding | Yes | No | Yes |

COMPLETION

From the outset, the string had been engineered and designed to meet the requirements of completion, because Unocal had planned on using the drill string as a completion string once it neared the end of its fatigue life. Once the drilling started, however, Unocal decided to install gas lift mandrels. A 4 ft-in. gas lift mandrel would not fit inside the production casing string. There were also material changes to the completion string that dictated using 13 percent Chrome tubing instead of the P-110. Therefore, it was not used as a completion string as planned.

The conclusion of the project, according to Mr Kelly, was that the string and the MPD system performed flawlessly throughout all operations – drilling, reaming, washing, perforating, fracing, gravel packing, cementing, setting packers and milling windows.

“These are worth noting because they aren’t common operations for a tubing

string,” he pointed out. “They’re common for a drillpipe string.”

Other advantages identified during the project were:

- The use of one string allowed more flexibility on deck space;

“This project proved that there are certain applications where a tubular connection will work better (than drillpipe).”

**Hydril Technical Services
Manager Ben Kelly III**

- The upset tubing in harmony with Weatherford’s MPD system proved to decrease wear on stripping rubber along with maintaining seal;

- Using tubulars provided increased hydraulics over conventional drillpipe (small OD vs. large ID) and allowed for better performance at the bit;

- Overall, less than 1 percent recuts will be required to repair the string. That means out of a total of 400 joints, about 4 recuts will be required.

Will tubular connections ever replace drillpipe? Probably not, Mr Kelly said. “But this project proved that there are certain applications where a tubular connection will work better.” ■