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PRODUCTION HYDRAULIC PACKER FIELD TEST

Field Report for the period of

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Tricia Schneller, Halliburton Energy Services
Jose Salas, RMOTC (PDVSA, Venezuela)

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DOE CRADA No. 2000-001

Rocky Mountain Oilfield Testing Center

907 N. Poplar, Suite 150

Casper, WY 82601

(307) 261-5000

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Project Manager:	Douglas Tunison
Project Engineer:	Jose Salas
Other Major Contributors:	Ralph Schulte
Contracting Officer's Representative:	Barbara Tucker

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Abstract

In October 1999, the Rocky Mountain Oilfield Testing Center and the test client cooperated on a field test of new Production Hydraulic Packer technology on Well 46-TPX-10 at Naval Petroleum Reserve No. 3 near Casper, WY. Performance of the packer was evaluated in set and unset operations. The packer ability to seal the annulus between the casing and tubing was hydraulically tested and the results were recorded.

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Introduction

Hydraulic production packers are a mechanical device used to complete oil and-gas wells in order to isolate different production zones from each other or the rest of the wellbore. The availability of various types and sizes allows engineers to design their wells according to their individual requirements and cost effectiveness.

The client developed a new type of production packer that uses an unconventional setting procedure, which has to be tested before going to the market. Based upon the requirements for packer design, a field test was designed to run a packer in a well, and test the ability of the packer to be set and unset, as well as its sealing capability under pressure differentials.

The test well was selected to provide a real well environment required for this particular packer. These conditions included a well about 5,000 ft deep, and cased with 7 inch casing, with fresh water as a completion fluid.

WELL INFORMATION SUMMARY

Well Name	46-TPX-10
API Number	049-025-22770
Lease	Naval Petroleum Reserve #3
Field	Teapot Dome
County, State	Natrona County, Wyoming
Ground Level	5258
Kelly Bushing	5268
Surface Location	Sec. 10, T-38N, R-78W
Surface Coordinates	' FSL,' FWL
Total Depth	5630 ft

DESCRIPTION OF THE TECHNOLOGY TESTED

RMOTC's test partner developed a new system for the remote, interventionless actuation of downhole completion equipment. Conventional methods to set Production Hydraulic Packers employ a dropped or circular ball, coiled tubing, or slickline to run a tubing or casing plug. The new system provides a safe, reliable and more cost effective alternative to the conventional intervention. It is based on a newly developed acoustic telemetry that uses the tubular fluid to propagate a predetermined pressure pulse sequence. Upon the successful detection and decoding of the pressure pulses by a downhole electronic module, a command is

issued to activate the setting of a Production Packer. An unlimited number of packer or other hydraulically activated devices can be remotely activated in any desired sequence.

APPLICATION POTENTIAL OF THE TECHNOLOGY

The new technology developed decreases the time to set Production Hydraulic Packers and extends the operating depths to deep, highly deviated or horizontal offshore environments. Since the new system eliminates the need to circulate a ball downhole to set the service tool, a constant hydrostatic pressure can be maintained decreasing the risk of formation collapse, fluid losses and formation damage.

GENERAL NOTES ON THE TEST

The following information is designed to provide a general idea of the Production Hydraulic Packer test performed in the well 46-TPX-10 at the NPR-3 lease. This test was affected by unexpected situations during testing operations.

1. Field operations started on October 21, 1999. It was planned to conduct the test in two phases. The first phase was designed to accomplish the requirements or minimum conditions regarding well conditions needed to run the packers. This phase took four days, which exceeded the planned time for this task of two and half days. The second phase was designed to perform the packer test, which consisted of running the packer, setting the packer, hydraulically testing the annular seal, and unsetting the packer. This phase took three days, as planned.

2. During tripping in, the casing scraper and bit would stack out (i.e., lose string weight). At this point, the operator would work the pipe by applying approximately 4 – 6,000 lbs of set down weight and circulating the hole. The pipe would gain weight indicating that the obstruction had been washed out from around the bit and scraper. The pipe would then be lowered and often encountered another obstruction, a few feet lower. The process would then be repeated.

The condition of the wellbore was unknown; it had not been entered since the client's prior test in October 1998. The heavy mud (i.e., 12.7 ppg) used during the previous test was left in the wellbore in anticipation that the client or another service company would require the heavier mud again. The mud even in the liquid environment of the casing appeared to form rings along the inside diameter of the casing. The exact nature or cause of these rings is still debatable; however, the result was additional workover time was required to reach the bottom.

3. Despite the first phase being completed when we reached the bottom of the well, the condition of the well remained poor. Heavy mud was left in the hole and the test was affected as follows:

a. The test was planned for a dual packer run in order to simulate a multiple sand completion and test the ability of the packers to be selectively set. Since the clean up process was ineffective, and the casing scraper wasn't dressed properly for 7" 20# casing (scraper undergage due to wear), there was a potential risk of stuck pipe due to the mud solidification around the casing wall. Therefore, the test partner decided to run only one packer, instead of two as originally planned.

b. As part of the test a polymer pill had to be pumped into the well and placed five hundred feet above the packer. However, due to the heavy mud left in the hole the pill reversed back up to 2,500 ft above the packer, because of the hydrostatic underbalance caused by the heavy mud in the casing annulus. This “U-tube” effect produced thirteen barrels of backflow from the tubing.

c. Finally the test was performed and the test partner was able to establish communication through the pill and set the packer.

DAILY ACTIVITIES SUMMARY

Thursday, 10-21-99

Start	Finish	Duration	Activity
7:00	9:30	2.5	Ran in the hole with 2-7/8” tubing, casing scraper, and bit to 3,832’ without problems.
9:30	12:00	2.5	Tagged fill at 3,832’. Pumped water into the hole with water truck, took 64 bbl down tubing to see mud in returns. Washed down to 3,900’.
12:00	5:00	5	Washed down to 4,178. There was still gray water coming out of the hole.
5:00	6:00	1	Picked up one stand and tagged approximately 1-1/2 joints in on this stand. Shut down workover unit for weekend.

Monday, 10-25-99

Start	Finish	Duration	Activity
7:00	11:00	4	Tagged up halfway in on joint number 132, approximately 20' higher than Thursday afternoon. Current depth 4,250'. Could not get deeper due to insufficient pump rate. Decided to use maximum water truck pumping rate available, approximately 2 bbl/min. Calculated annular velocity at this rate to be 65 ft/min. Need a minimum of 150 ft/min. to clean out hole with clear water. Tried to start up circulating unit to get more rate. Would not start. Rigged up stripping head to reverse circulate.
11:00	4:00	5	Washed down to 4,300'.at a rate of six minutes per joint. Received orders to stop reverse circulating.
5:00	5:30	0.5	The drive line broke on the water truck. Tried to find another water truck without success. Decided to suspend operations until next day.

Tuesday, 10-26-99

Start	Finish	Duration	Activity
7:00	8:00	1	Ran in the hole to 4,300' without problems. Contract water truck arrived at the location.
8:00	9:00	1	Washed down to 4,434'. Started up circulating unit, but received orders not to use it.
9:00	9:15	0.25	RIH without circulation from 4434' to 4591' (5 joints)
9:15	10:00	0.75	Washed down slowly with water truck due to fill.
10:00	11:00	1	RIH without circulation until top of bridge plug at 5,332'
11:00	1:00	2	Circulating approximately 2 bbls/min.
1:00	2:15	1.25	Working on the wellhead. Contract water truck left location.
2:15	3:30	1.25	Tripped out of the hole with 2-7/8" tubing, scraper and bit from 5,332' to surface. The clients' equipment arrived on location at 2:15 PM. The winch truck was used for 15 minutes to unload the equipment. The vacuum truck was hauling water from the pit.
3:30	6:30	3	Tried to install a 3,000 psi wellhead, but could not break out old wellhead. Installed new nipples and valves on old wellhead. The Blowout Preventers (BOP's) were tested with 1,500 psi for five minutes with the circulating unit since the water truck could not reach the pressure required.
6:30	7:00	0.5	Picked up the clients' equipment (packers) using winch truck.

Wednesday 10-27-99

Start	Finish	Duration	Activity
7:00	8:30	1.5	Rigged up tubing tongs and elevator with the winch truck.
8:30	9:00	0.5	Waited for 3-1/2” slip-type tubing elevators.
9:00	9:45	0.75	Picked up packer.
9:45	1:30	3.75	Ran in the hole with packer to 5,200’.
1:30	1:45	0.25	Rigged up packer setting equipment. Mixed extender gel pill. Held pre-job safety meeting.
1:45	4:15	3.5	Finished mixing extender gel pill. Rigged up truck pumping line and performed hydrostatic test with 1,500 psi for five minutes. Pumped 5.8 bbl pill and 25 barrels of water to displace pill. U tube differential pressure of 250 psi was found on the tubing, indicating that the hole was not cleaned of the heavy mud. Opened the valve on the tubing and the well back flowed 13 barrels of water to equalize. The annulus still contained heavy mud.
4:15	5:45	1.5	Tried to set packer without success. Tried again with more pressure. Pick up one foot and gained tension, indicating packer was set.
5:45	6:00	0.25	Performed packer test. Held 1,200 psi on casing annulus, indicating a hydraulic seal was attained.
6:00	6:30	0.5	Performed client unset procedure twice without success.

Thursday 10-28-99

Start	Finish	Duration	Activity
7:00	10:00	3	Dropped ball and applied pressure to release packer. Tested packer. It was still set. Tried again to release packer and succeeded.
10:00	10:15	0.25	Reversed circulation to recover ball. Ran out of water.
10:15	10:45	0.5	Waiting for water truck. Contract water truck left location.
10:45	1:30	2.5	Reversed ball out and pulled out of hole with 2-7/8" string.
1:30	6:00	4.5	Picked up another packer and ran in the hole to 5,100'. Tried to set the packer several times without success. Decided to pull out of the hole with packer.

Friday 10-29-99

Start	Finish	Duration	Activity
7:00	10:30	3.5	Finished tripping out of the hole with packer. Packer not there.
10:30	12:30	2	Picked up packer fishing tool and ran in the hole to recover packer.
12:30	1:30	1	Problems trying to recover packer. Finally packer unset.
1:30	3:00	2.5	Tripped out of the hole with fishing tool and packer.
3:00	3:30	0.5	Laid down packer and shut down workover unit.

Monday, 11-01-99

Start	Finish	Duration	Activity
7:00	12:00	5	Ran in the hole with the work string to break down singles. Break down 2-7/8" tubing and shut down workover unit.

ACTUAL TEST COST

The total cost associated with mobilization, well preparation, and field-testing, and mobilization of personnel, materials, equipment and services necessary to conduct the test is $77,276.02.

TECHNICAL RESULTS OF THE TEST

- Tests conducted during the week of October 25 – 29, 1999, confirmed the successful operation of the new system, and revealed some areas for improvement.
- A minor problem in the surface air gun control program that sets the timing of the acoustic signal sent through the tubular content was discovered.
- Inconsistencies in the functioning of a new version of the firmware were also identified.
- Built-in redundancy provided by the contingency setting method, improves overall reliability performance.