Abstract

As part of an abandonment campaign started in Feb 2013, Chevron had decided to permanent plug 3 gas producer wells and 2 water producer wells in the Ballena Field, with the main challenge of the footprint of equipment to be used because the original locations were eroded by sea and there was no possibility to use a conventional work over rig. This document presents 2 case studies where a significant advance in the slickline technology that incorporates cutting-edge benefits such as real time visibility and interaction and control, while maintaining slickline advantage simplicity had overcome the project’s challenges allowing time and cost reductions.

Introduction

The Ballena field began gas production in 1977 and is operated by Chevron in partnership with Colombia’s state oil firm Ecopetrol. Currently, gas production in Colombia is highly concentrated to three fields - offshore platforms Chuchupa A and B and onshore natural gas field Ballenas in La Guajira province of Northern Colombia (Fig 1).

Between 1976 and 1982 as part of the development phase of Ballena field the wells Ballena 04 and 12A were drilled and completed. After more than 30 years producing, a constant pressure build up in the annulus section outside the production string was noticed, most likely related to an isolation problem in the well. To remediate this lack of well control a decision to temporarily abandon using mechanical plugs and control fluids was implemented in 2011. The abandonment program includes the use of Coiled Tubing Unit, Cement Pump, Electric Line Unit and Slickline Unit in the sequence showed in Fig 2. The objective --- to force cement into the formation, set a second cement plug, squeeze a superficial cement plug through annular space and at the end disassembly the x-mas tree.
To accomplish the final abandonment of these wells and with the main concern of operating in an environmentally sensitive zone along the shore line which has been eroded by the sea (Fig 3), the equipment and technology to be used had to allow rig less thru-tubing operations with the minimum lay out impact possible to the environment.

In such scenario, the strategy to overcome this challenge was the use of a new technology enabler that reduces the amount of people and trucks on location, while delivering the same confidence of standard equipment available in the market. The following case studies present the methodology and field application of the technology and show the results for the 2 wells.

**Technology Implementation**

Slickline is a key service in most of the Plug and Abandon (P&A) operations for conveyance purposes or just plain economics. However, the limited capabilities of slickline based on deployment of battery-powered electronics or memory-based tools had always complicated the P&A programs, including additional runs in hole as execution quality control is limited to post job.

Today’s stringent local regulations require that jobs to be carried out with high quality in activities such as perforation, punching, cutting, device setting; which effectively cause assignment only to electric line conveyance, increasing the amount of work force on location, logistics and primarily increasing the cost. Meanwhile the expected norm in industry is to minimize operational risk, delivering efficiency, operational simplicity and overall cost effectiveness. (Murchie S, et al, OTC 23916)

Lightweight, low footprint intervention systems can significantly lower cost if they can offer the broad range of services required. These involve ability to deploy in an effective and safe manner, the elimination of grase injection pressure seal, ability to conduct real time QC in operations, HSE exposure reduction, and integration of remedial and measurements services along with routine mechanical services. This is enabled today in digital slick line units.

With telemetry enabled slickline, real time data acquisition and control capabilities become possible. These include acquisition of tool string shock, well deviation, head tension, downhole pressure/temperature, GR/CCL positioning and the possibility of multiple combinations for memory-based triggers and electronic tools, which now correlated on depth. Digital slick line becomes a solution for an effective cost control and time reduction during P&A operations as demonstrated in the following case studies for the wells in the Ballena field.

**Case History # 1, well Ballena 04**

Ballena 04 was drilled and completed between August 21st and September 17th 1976, it reached a depth of 5464 ft (MD) and considered as gas production well producing 12.6 MSCFD, after an acid stimulation. The mechanical diagram of the well showed in the Fig. 4 has a 9-5/8in casing up to 2196 ft, with cement behind through surface and a production casing from surface to 5413 ft, with the top of cement at 4022 ft. Several interventions were previously performed, especially to remedy the production string from continuous pressure increase in the annular section between the production completion and the casing. In 2009, the pressure inside and outside production string was the same and the well was declared for abandonment, leaving the well killed with 20 bbls of brine, cleaning until 5177 ft WLM and with a blanking plug set at 5015 ft. The rest of the well was filled with 70 bbls of water and the final well head pressure was 0 psi. (Arcila, G. et al, 2013)
Local regulation dictates all the tubulars to be removed from the well before abandonment completed; but in this case as the ground erosion caused by sea at the well site did not allow a work over or pulling rig or even a snubbing unit to be used. An exemption process to abandon the well with the tubulars left in place needed some modification to the normal program and the main steps requested were:

- Gauge runs (tubing, HUD)
- Blanking Plug retrieval
- Bullhead cement (500 ft)
- Tag cement top
- Perforate @ 2,000 ft using 2” gun to communicate 3 ½” + 7” + 9-5/8” tubulars
- Pump cement plug #2
- Calibrate tubing
- Chemical Cutter @ 30 ft

The use of digital slick line in combination with pressure activated firing head allows all the mechanical operations correlated on depth to be performed. Two perforating runs at 2,000 ft and 294 ft with real time GR-CCL correlation and 2 5/8” Chemical Cutter at 15 ft from surface allowed complete abandonment of this well. All activities were accomplished in 6 days, working only daylight hours without the use of any additional resource.

Also, using the logs from shock and vibrations sensors on the basic measurement catdrige of digital slick line, a surface feedback of detonation in both perforating jobs and chemical cutter were detected and registered.

**Case History # 2, well Ballena 12A**

Well Ballena 12A was completed as gas producer well in 1982 reaching a depth of 6333 ft (MD) similar to the well Ballena 4 covered in the previous case history. This well presents isolations problem presumably located in the packer, production pipe or tubing hanger. During 2009, the well was declared for abandonment according to API-RP 90 standards. This well was killed with 26 bbls of brine, cleaned until 6242 ft WLM and with a blanking plug set at 6112 ft. The rest of the well was filled with 87 bbls of water and the final well head pressure was 0 psi as shown in Fig 6. (Arcila, G. et al, 2013)

Different from well Ballena 4, this job did not require the pipe to be cut at surface considering only the following steps:

- Gauge runs (tubing, HUD)
- Blanking Plug retrieval
- Bullhead cement (500 ft)
- Tag cement top
Perforate @ 1,700 ft using 2” gun to communicate 3 ½” + 7” + 10 ¾” tubulars
Pump cement plug #2

The entire operation lasted 5 days (daylight activity only) and the results were monitored and registered using digital slick line.

The results of the two abandonment jobs were satisfactory and helped in reduction of operating time and thus, AFE of the well.

Conclusions

All interventions performed in these wells were developed with different configurations of tools attached to a digital slick line to log real time pressure, temperature and GR/CCL for depth correlation.

The perforating activity designed to allow communication across three tubulars was successfully deployed using a combination of digital slick line and a pressure activated firing head with a real time feedback of detonation.

The chemical cutter performed at 17 ft from surface represented a challenge with increased risk that was executed successfully after implementation of control measures suggested by technical support of the digital slick line team.

Digital slick line has become a cost reduction solution for P&A campaign due to the smaller logistics and complete portfolio of solutions.

Acknowledgments

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References


Nomenclature

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<th>Description</th>
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<tr>
<td>GR/CCL</td>
<td>Gamma Ray / Casing Collar Locator</td>
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<tr>
<td>MD</td>
<td>Measure depth</td>
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<tr>
<td>MSCFD</td>
<td>Million Standard Cubic Feet per Day</td>
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<td>WLM</td>
<td>Wire Line Measured</td>
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SI Metric Conversions

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<tr>
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Figures
Slickline operations:
Check mechanical conditions of the tubing and recover the blanking plug

Coiled tubing operations:
Pump cement plug #1 through the producing intervals (10 Bbls cement)

Wireline and Perforating operations:
Perforate tubing and squeeze cement plug #2 thru annular space (500')

Wireline and Perforating operations:
Perforate tubing and production casing. Squeeze plug #3 thru annular space (800')

Fig 2. Diagram of Completions Program
Fig 5. Logs and results from digital slickline real time monitoring in Ballena 4.
Fig 7. Logs and results from digital slickline real time monitoring in Ballena 12 A
Fig 8. Final status of wells Ballena 4 and Ballena 12 A after abandon.