Abstract

An 80m long retrievable “one-run” straddle assembly was successfully installed in order to shut off a gas breakthrough in the 130 degrees deviated reservoir section of a “U shape/Fish hook” sub sea oil producer in the Njord field. Coiled tubing with an internal electric line in combination with a tandem fluid driven tractor was used to convey the straddle assembly.

Introduction

Njord is a sub sea completed oil field operated by Hydro, located offshore northwest Norway. Njord “A” is a floating drilling and production unit. The well is an oil-producer in the Tilje formation, completed with a 7-in” production tubing and a 7-in” perforated liner (Fig 1&2).

The objective was to isolate selected intervals in the reservoir section at 130 degrees inclination in the “toe” of the well in order to reduce the gas to oil ratio (GOR). The chosen method was to install a purpose designed straddle packer assembly utilizing coiled tubing and tractor.

Job design

Based on computer simulations, it soon became clear that it would not be possible to reach the desired depth using coiled tubing and conventional “extended reach” techniques alone.

Computer simulations using reduced friction coefficients and/or altered fluid densities only improved results marginally and indicated that the 2-in” (optimized taper) coiled tubing at best would go into a lockup 174 meters away from target depth. Computer simulations using 23/8-in” coiled tubing also showed similar results with a little added penetration.

CoilCAT* software was used for modeling of tubing forces in the well.

Based on these simulations a coiled tubing tractor (Fig 3) was recommended to extend the conveyance reach to the target depth. The tractor supplier stated that 3000 lbs pull force would be available from the fluid driven coiled tubing tractor. Computer simulations performed using 3000 lbs (13kN) pull force on the straddle assembly in combination with the available coiled tubing push, indicated that bottom of well could be reached. (Fig 4 presents plot of simulation result with and without tractor). This would be the first time electrical tools were used in combination with the fluid driven tractor.

A new adapter sub was required to use tractor with e-line integrated for surface data readout. The adapter design was based on an existing coiled tubing cable head design with added functionality to allow higher flow rates directed down through the emergency disconnect section instead of the normal circulation path into the coiled tubing annulus.

A test of the new cable head adapter with tractor was performed onshore to verify the flow-through characteristics, disconnect functionality, tractor performance and electrical integrity. The measured parameters from the test were later used when setting up the tools and tractor for the operation.

To be able to run the required tool string (Fig 5) for the straddle packer assembly the tractor top connector and compensator were re-designed.

Special attention was given to the connection between the setting tool and the casing collar locator. On standard tools, this is a relatively weak connection, mainly meant for tools to be run on wireline. In order to ensure that tools were not accidently lost in hole, the top adapter thread on the setting tool was changed to a CAL-B connection, which is larger and will give more resistance to bending forces that would occur during the run in and setting operations.

A tandem tractor configuration was required to achieve required pull force based on the available flow rate.

The packers at each end of the straddle packer assembly (Fig 6) were custom-made to special outer diameter of 5.5-in” in order to pass a 5.75-in AOF nipple and several doglegs in the well. The internal diameter of the packer setting area was 6.094-in. It was identified that the bottom hole assembly could become heavy and therefore difficult to get to the target depth. Based on simulations, a 3-1/2-in” 9.2pounds per foot spacer pipe was selected.

The straddle packer assembly was selected to be fully retrievable. Retrieval of the straddle is achieved in two runs,
where the first run releases the lower packing unit. The second run releases the upper packing unit and the slips section. The straddle can then be retrieved.

**Job execution**

A gauge run with a “dummy straddle” was performed. A real time surface readout production log was then run to determine the exact interval of the gas breakthrough. Evaluation of the log concluded that 66% of the gas was produced from the perforations in the “toe” section of the well from 4196 m to 4276 m.

When running the straddle packer assembly into the toe section of the well, lock-up was experienced at 4160 meters MD at 113 degrees inclination. This was fully in accordance with simulated lock-up depth. The tractor was activated by pumping 140 liters per minute, successfully conveying the straddle assembly down (or rather up) to 4312m MD at 130 degrees inclination. The straddle packer assembly was then pulled back to the setting interval (Fig 7). Predicted coiled tubing forces versus experienced parameters are explained in attached plot (Fig 8).

An electrically operated hydrostatic setting tool was used to set the straddle packer assembly, being the first time this particular combination of tools has been successfully placed in a well under live conditions, ending up with a 80 m straddle in the well set across the planned interval (Table 1&2).

**Presentation of Data and Results**

Prior to this intervention, the oil production varied between 0 and 800 Sm³/D with the well periodically shut in due to gas processing limitations.

The result of the intervention was encouraging: The GOR was reduced from 3000 to 1600 Sm³/Sm³ and the oil production was boosted to 1500 Sm³/D. Investment was returned within in 35 days by the increased oil production.

**Conclusions**

It is proven that we can plan and prepare for a “one run” placement of an 80m straddle in a 130 degrees inclined well section.

The combination of coiled tubing, well tractor and medium expansion packer technologies was the key element to this success where oil production was restored.

**Acknowledgments**

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We would also like to thank all personnel and suppliers involved in making this project a success.

**References**


**Tables**

Table 1 - Depths of the installed straddle;

<table>
<thead>
<tr>
<th>Top of Straddle @ 130 deg. Dev.</th>
<th>4193.96 mRKB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element Upper Straddle packer:</td>
<td>4195.26 mRKB</td>
</tr>
<tr>
<td>Element Lower Straddle packer:</td>
<td>4275.00 mRKB</td>
</tr>
<tr>
<td>Bottom of Straddle:</td>
<td>4277.28 mRKB</td>
</tr>
</tbody>
</table>

Total isolated zone: 79.74 m

Table 2 - Main dimensions of the straddle;

<table>
<thead>
<tr>
<th>Description</th>
<th>Max OD</th>
<th>Min ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Straddle Packer</td>
<td>5.50 in</td>
<td>3.64 in</td>
</tr>
<tr>
<td>3-1/2-in Spacer Pipe</td>
<td>4.25 in</td>
<td>2.992 in</td>
</tr>
<tr>
<td>Lower Straddle Packer</td>
<td>5.50 in</td>
<td>2.75 in</td>
</tr>
</tbody>
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Total weight of Coiled Tubing BHA: 2000 kg in air

"An asterisk (*) in this publication denotes a mark of Schlumberger."
Figures

Fig 1 Well sketch:

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