**CASE STUDY**

**PRESSPro RT Software Secures Success of HTHP Well in the North Sea**

“The quality of the PRESSPro* RT model and care with which it was calibrated resulted in the team gaining real faith in the data it provided, faith further confirmed by the agreement of the PWD data. It allowed us to obtain a real sense of being able to ‘see’ what was going on downhole.”

Client Drilling Superintendent

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**Well Information**

Location .............................................................................................................. Block 22, UK Central North Sea
Well type ............................................................................................................. Exploration
Date ....................................................................................................................... April 2006
Maximum deviation ........................................................................................... 0°
BHST ...................................................................................................................... 385°F (196°C)
Well depth .......................................................................................................... 17,500 ft MD

**The Situation**

This was a high-temperature/high-pressure (HTHP) well in the Central North Sea with a tight operating window. The projected bottomhole static temperature (BHST) was 380-400°F (193-204°C). An Annular Pressure-While-Drilling (APWD) tool was to be run; however, it was not certain that it would function at the expected bottomhole temperatures. In addition, APWD tools do not provide data when tripping/running casing.

**The Solution**

The PRESSPro RT wellsite service was recommended to complement the APWD tool in case of failure and to provide pressure predictions when tripping and running casing. As APWD data became intermittent and eventually stopped in one section, the PRESSPro RT solution proved effective.

**The Results**

The service was instigated in the 12¼-in. section to help familiarize crews with the product and to control swab and surge within the hydraulics window set (14.6-16.2 lb/gal). As there was no APWD in the 12¼-in. assembly, the PRESSPro RT software was calibrated to the standpipe pressure while drilling. Bottomhole circulating temperature (BHCT) was available from the measurement-while-drilling tool. An APWD was run in the 8½-in. hole section, which had a hydraulics window of 17.1 - 18.1 lb/gal. The PRESSPro RT service was used in tandem, primarily to monitor and control swab and surge pressures when tripping, where the lack of circulation meant that no APWD data could be obtained.

The PRESSPro RT service proved invaluable in the 8½-in. section when the APWD data became intermittent and eventually stopped altogether at 17,265 ft. BHCT surveys (from the MWD tool) continued to function normally. The hole was circulated clean at this point in preparation for pulling out, but instructions were received to continue drilling for geological data. There was sufficient confidence in the PRESSPro RT data to continue without the APWD tool. BHCT, standpipe pressure and previously recorded trends contributed to the accuracy of the PRESSPro RT predictions. A comparison between the equivalent circulating density (ECD) recorded by the APWD tool and the same values predicted by the PRESSPro RT software showed a good correlation.
The Details

Pre-emptive information gathering (PIG) tests were performed to document the well behavior in terms of certain drilling parameters, downhole pressures and flowback profiles. PIG tests #2, #3, #4 and #4B were of particular interest in benchmarking the performance of the PressPro RT software.

PIG Test #2 (mud reference temperature) was performed throughout the well and showed a good correlation between the mud weights corrected to 120°F and the downhole density readings from the APWD tool. This gave confidence in the Virtual Hydraulics® simulation, which also showed that correcting the mud weight to 120°F would yield similar equivalent static density (ESD) values under the geothermal gradient of the wellbore.

PIG Test #3 recorded the effects of pump rate/pipe rotation on ECD and standpipe pressure. Prior to performing this test, an APWD ESD reading of 17.17 lb/gal was obtained. The corresponding number predicted by the PressPro RT simulator was 17.30 lb/gal, a difference of 0.13 lb/gal. This test involved taking ECD readings with varying flow rates and pipe rotation to find out the effects on downhole ECDs. The ECD values produced by each individual test on the PressPro RT simulator were consistently off by 0.10-0.17 lb/gal compared with the APWD, indicating good correlation. The difference was ascribed to an uneven mud weight in the circulating system, which is difficult to model.

PIG Test #4 and #4b looked at swab and surge pressures and ECD effects caused by washing down with pipe rotation. This test was performed by taking APWD ECD readings while pulling/running stands with varying flow rates/rotation. Good correlation could be seen with the surge tests with differences between measured and calculated ECDs generally less than 0.1 lb/gal. In the swabbing tests, the calculated ECD was 0.08-0.19 lb/gal greater than measured. The consistency in the PressPro RT predictions confirms the accuracy of the models used in the software. Differences between the calculated and measured ECDs can be explained by slightly uneven mud weight in the wellbore at the time of the tests and also by changes in the rheological properties of the new fluid as it became “sheared in.” Some of the PIG tests also indicated that the APWD readings gave unrealistic results. For example, during PIG #4, increasing the pulling speed from 60 ft/min to 90 ft/min did not change the APWD ECD reading.

The table below summarizes the comparison between measured and predicted ECDs at various stages during drilling.

<table>
<thead>
<tr>
<th>Depth (MD)</th>
<th>15,330 ft</th>
<th>16,450 ft</th>
<th>17,290 ft</th>
<th>17,500 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>APWD ECD (lb/gal)</td>
<td>17.92</td>
<td>17.74</td>
<td>-</td>
<td>18.09</td>
</tr>
<tr>
<td>PressPro RT ECD (lb/gal)</td>
<td>17.98</td>
<td>17.74</td>
<td>18.21</td>
<td>18.09</td>
</tr>
</tbody>
</table>

Questions? We’ll be glad to answer them.

If you’d like to know more about the PressPro RT software and how it’s performing for our other customers, please call the M-I SWACO office nearest you.