geoconvention
Virtual Event
September 13 - 15
2021

Optimized Well Production Using Flow Control Devices: A Case Study in Successful Subsurface Team Integration

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Summary

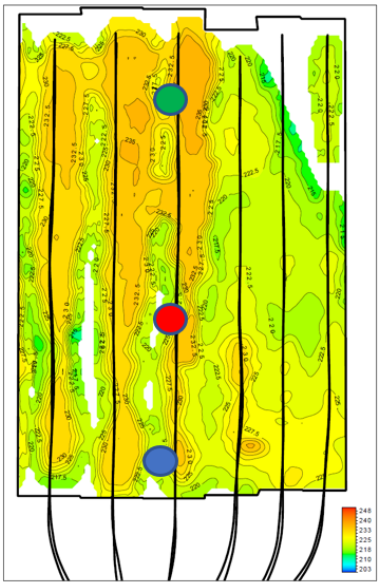
Efficient production of the McMurray formation with SAGD requires a deep understanding of the reservoir. Even with high well delineation, and a comprehensive interpretation of the data, understanding the drainage and steam conformance within the reservoir can only be achieved with full integration of the geology, geophysics, reservoir, and production teams. Once this is done, the team can incorporate production enhancement projects that ensure a high rate of success as well as a high rate of return.
Within Athabasca Oil Corporation's (AOC) Leismer asset, Flow Control Devices (FCDs) have been used a means to optimize well production rates from limited drainage areas.
The results indicate that production rates have increased post FCD install and have been successful in increasing drainage along the wellbore. These rate increases are supported from 4D seismic data, observation well monitoring such as reservoir saturation logging and thermocouple data as well as in-depth reviews of static well log data and facies interpretation.
In 2017, a tubing conveyed FCD was installed in the producer well of pair four of pad three (L3P4). This case study will present the data used by the team to select the FCD candidate. It will then show how the reservoir reacted to the installation and the metrics used to gauge its success.

Theory / Method / Workflow

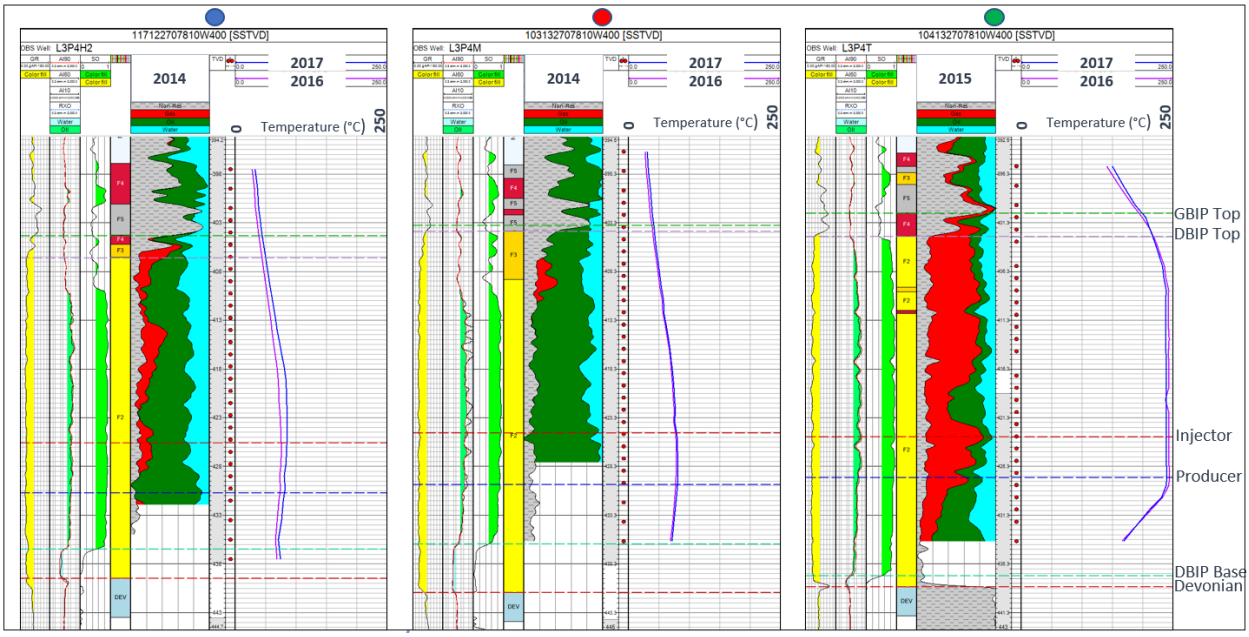
FCDs are used to restrict the influx of steam at hot points along the producer. By doing this, fluid from cooler sections of the horizontal can be produced, as opposed to slowing a well down to limit steam ingress.

When ranking criteria for installing an FCD, the first metric to be considered is potential production uplift. After determining if it is economic, one must evaluate the geology and seismic data to validate the potential.
L3P4 was brought on production in 2011 and had strong production. Although there were fluctuations, rates plateaued until 2014 and rapidly dropped off in 2015. A hotspot developed near the toe of the well.
By extrapolating the production rate according to typical decline rates and comparing it to the current rate, this provides a modest estimate of potential uplift for FCD install.
The base assumption is that the FCD would improve temperature conformance along the well, returning production to near pre-constrained rates. At the time of selection, the recovery rate was ~37%, so it is very unlikely that this rapid production loss was related to natural decline.

Petrophysically, the reservoir is similar with very high-quality sand dominated facies along the horizontal. Thermocouple data in these wells are spaced on average 1 TC/m.



2014 4D Anomaly



The heel to mid portion of the horizontal was relatively cool in 2017 and exhibited limited growth from 2016-2017. The toe portion of the well was at full steam temperature. The most recent 4D seismic survey prior to FCD installation was in 2014 showing the approximate elevation where bitumen is thermally mobilized.

This shows that there is strong conformance at the toe of L3P4, confirmed by the hotspot. At the location of the heel and mid OBS wells, the 4D anomaly is not present.

In 2014, the most recent saturation surveys for the heel and mid OBS wells, there is limited gas liberation present. Based on the low L3P4 recovery factor prior to the FCD installation, it was determined that most of the drainage was from the toe of the well. FCD installation was recommended as it would encourage overall chamber conformance and installation commenced in Q3 2017.

Results, Observations, Conclusions

Post FCD install, drainage immediately increased. At L3P4T, the temperature profile is very similar to pre-install. The TC data shows that the top of the chamber has not moved since 2017. At the producer elevation near the toe, the temperature has slightly decreased due to reduced steam influx. At the heel L3P4H2, the TC data shows a slight temperature increase in 2018. A large temperature increase was observed in 2019. The mid OBS well, L3P4M indicates that there is full chamber development shortly after the FCD install in late 2017. The 2018 saturation log shows that the base of drainage is well correlated to the TC data with ~8m of drainage from 2018 to 2020.
In 2020, the top anomaly shows full conformance along the well pair.
Production data after install in late 2017 shows that there was an initial oil uplift and a sustained increase over the next 3 years. Post-FCD, the hotspot at the toe no longer exists and there is a slightly lower and flatter temperature profile along the horizontal.
Overall, FCD deployment has been successful across the Leismer asset. Steam chamber conformance as well as vertical drainage has improved where FCDs were installed

Novel/Additive Information

To determine the optimal deployment of FCDs in the field, a multidisciplinary approach was taken to candidate selection. Reservoir and production initially select candidates based on well performance metrics and then pass this list off to G&G. G&G reviews the subsurface static and dynamic well data to rank the selection for the best possible success. Once the surveillance data, 4D, RSTs, temperature and production data are evaluated, the completion is designed for the specific horizontal. After the install is completed, evaluation of production rates and observation wells will validate the success of an FCD completion.
In the case of L3P4, this evaluation showed that there was immediate production increase and the subsequent temperature, saturation and 4D seismic data pinpointed the location from where this oil drained.