FIELD PILOT OF MULTILATERAL WELL TECHNOLOGY TO REDUCE GHG EMISSIONS INTENSITY IN SAGD
NON-CONFIDENTIAL FINAL REPORT

ERA AGREEMENT NUMBER: E0160397
PROJECT COMPLETION DATE: MAY 31, 2022

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Rev	Date	Issued for	Originator	Reviewer	Approver
0	05/31/2022	APPROVAL	JAVIER SANCHEZ		

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1.0 Executive Summary

Steam Assisted Gravity Drainage (SAGD) projects that develop and produce Alberta's oil sands are recognized as some of the highest cost and greenhouse gas (GHG)-intensive oil extraction operations in the world. The bulk of the cost comes in well drilling, completion, and construction of surface facilities. GHG emissions result from steam generation and suboptimal steam utilization in the reservoir. Improving the cost structure and environmental performance of existing and future SAGD expansion projects is critical to maintain and increase the attractiveness and competitiveness of Alberta's oil sands.

A pilot project was implemented by ConocoPhillips Canada (CPC) to design and execute a field trial of the multilateral (MLT) well technology to 're-develop' its in situ asset, Surmont, through an infill well campaign. Infill wells can be used to access the wedge of unrecovered bitumen that forms in the space between two existing well pairs. This wedge of bitumen is surrounded by the steam chambers of the adjacent SAGD well pairs, but in the absence of an additional producer well in the wedge, the bitumen will not get produced. This bitumen could be produced with conventional infill wells; however, in a lower oil price environment, stand-alone infill wells are no longer economic.
CPC proposed project addressed this issue using multilateral infill well technology. Multilateral wells are innovative drilling and completion technologies that allow drilling multiple lateral boreholes within a single main bore (either pre-existing or newly drilled). Multilateral wells allow operators to improve reservoir production by increasing the contact area between the wellbore and bitumen formation. In addition, new production zones can be accessed with minimal increase in drilling and completion costs. The multilateral well technology has the potential to improve the performance of SAGD operations by increasing oil production and reducing GHG intensity at a reduced cost in comparison with developing new well pads.

The pilot was executed from 2019 to 2022 at CPC's Surmont SAGD Project where three infill producer wells were drilled off existing SAGD producer wells and tied in to existing Surmont surface facilities. **The pilot achieved a reduction in GHG emissions intensity of 35.7%, which is equivalent to a reduction of 24.88 kg-CO2e/bbl**.

2.0 Background

ConocoPhillips Canada (CPC) has spent many years optimizing wellbore architectures to achieve a more efficient production of its asset. Back in 2012, an original attempt to drill and complete infill wellbores with hook shaped toes was implemented in two wells in the Surmont 1 area, with the objective draw the nearby heat from adjacent SAGD well pairs. Then, in 2013, the Surmont drilling team achieved record length SAGD horizontal sections of approximately 1400m long, as part of the Surmont 2 project area. Also, between 2013 and 2014, the execution of two infill wells with open hole "fishbones" was successfully completed in Surmont 1. However, CPC's Technology evolution has continued looking into ways to unlock further value by implementing novel well architecture designs. This led into the evaluation and design of the multilateral wellbore technology to eliminate the need of surface tie-ins from typical infill wells.

The multilateral technology could bring the following potential benefits:
For existing pads:

- Add infills with essentially no tie-in costs

For future pads:

- Unlock variable spacing opportunities
- Future capital flexibility
- Lower cost tie ins

A pilot project was developed in 2019 which consisted of three multilateral candidates at different locations in the Surmont development area. A scoping and ranking methodology was used to evaluate the best candidate locations for deployment of the infill MLT wells, which consisted in the following deployment cases:

1. Failed producer(s) requiring new well from surface with MLT
2. Failed producers(s) with ability to re-enter well for sidetrack with MLT
3. Proactive Re-entry of producers to complete MLT
4. New MLT wells from surface spare slots where available

The opportunities where then ranked based on reservoir quality and theoretical volumes within the infill wedges, by using a confidential methodology developed by CPC. After evaluating the final ranking and taking into account the deployment considerations, the final candidates were selected.

3.0 Multilaterals Execution

3.1. First Multilateral Wellbore

Drilling of the first MLT system was completed in Q3 2019. A High friction zone was encountered due to a muddy section at heel of the well, which led to cold temperatures and inability to push the liner completion in the MLT leg all the way to planned total depth. From this, the decision was made to reduce the liner length and ensure setting up junction, which would be part of the success metrics for the first milestone in landing the junction in place.

From an operation standpoint, due to the shortened MLT leg section compared to the original plan, the colder temperatures in the area required the wellbore to be warmed-up prior to attempting to put the system on production.

Complications with well operations during the warm-up phase required to shut-in the system for further investigation and troubleshooting.

3.2. Second and Third Multilateral Wellbores

Based on the execution of the first MLT wellbore, lessons learned from the drilling and completion operations were taken into consideration for the execution of the last two wells. Both wellbores were drilled and completed successfully, landing the MLT junctions in place and the liner completions as per total depth plans. The second well went through a period of initial steam bullheading for warm-up operations which took a few weeks before going through the secondary completion phase for artificial lift installation. This allowed for an initial production measurement of the infill leg by itself, which would provide a performance baseline prior to opening the complete system for production (leg and mainbore combined).

The third well went through a similar operation sequence, however, the reservoir temperatures found in the MLT leg area while drilling were encouraging enough that no initial warm-up period was deemed necessary for this well. Hence, the artificial lift completion was run directly after drilling and the MLT leg was put on production for baselining.

Following the MLT leg production baseline period, a new completion operation took place in each well to open the mainbore for production and achieve full MLT system rates. Both wellbore systems have been on production since with very encouraging results

4.0 Reservoir Modelling

As the field trial of the first MLT wellbore was being executed, a concurrent reservoir modeling project was kicked off, with the objective to achieve a history-matched model of the wellbore and predict performance for evaluation of actuals. The following reservoir modelling methodology was conducted:

Performed Pad history match to ensure actual performance data from the wells in this pad is captured and performance predictability optimized.
Based on actual operations, the following performance modeling scenarios were investigated:

1. **CASE 1:** Modeling the MLT leg as a fully cased wellbore to total depth.
2. **CASE 2:** Modeling the MLT leg as a half lined / half open hole section.

After completing the history match for the pad, an MLT well was deployed in the model at the MLT leg location. The model effectively captured the muddy section at the heel and the warmed development in the reservoir area between the middle and toe sections of the wellbore.

Based on this modelling work, a forecast for the MLT well infill leg was complete, showing an overall increase in oil production from the system, which can then be used as a dynamic baseline to compare actual results from the well in the trial.

5.0 Conclusions

The pilot clearly exceeded the expectations and metrics set in the beginning of the project. Oil rate production uplift and steam-oil ratio (SOR) reduction observed to date are very encouraging from the execution of multilateral wells. The pilot achieved a reduction in GHG emissions intensity of 35.7%, which is equivalent to a reduction of 24.88 kg-CO_2e/bbl.

Building upon the success of this pilot, Multilateral systems will now be part of Surmont's commercial tools for optimization of current and future wells in the asset. The technology is defined as a commercial application for standardization of Multilateral candidacy evaluation on future sidetracks and development opportunities.