Air injection and displacement for recovery with oil horizontal (AIDROH) project Approval #11618 Performance presentation

Alberta Energy Regulator offices
Calgary
February 2016
Advisory

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AIDROH* introduction and overview

This presentation was prepared in accordance with AER Directive 054 - Performance presentations, auditing, and surveillance of in situ oil sands schemes

Subsurface issues related to resource evaluation and recovery
  • Directive 054, Section 3.1.1

Surface operations, compliance, and issues not related to resource evaluation and recovery
  • Directive 054, Section 3.1.2

* Canadian patent CA2594413
AER Dir 054 Section 3.1.1

Subsurface issues related to resource evaluation and recovery
Subsurface issues: Table of contents

- Scheme background
- Geology/geoscience
- Drilling and completion
- Artificial lift
- Instrumentation
- Scheme performance
- Future plans
Scheme background

Subsurface section 1

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Background

The AIDROH project uses gravity drainage as a bitumen recovery process to recover bitumen that has been passively heated by the Cenovus EnCAID combustion project.
Location map
Geological/geoscience

Directive 54
Subsurface section 2

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**Summary of reservoir properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>465m TVD</td>
</tr>
<tr>
<td>Thickness</td>
<td>25-30m</td>
</tr>
<tr>
<td>Average porosity</td>
<td>35%</td>
</tr>
<tr>
<td>Average bitumen saturation</td>
<td>65%</td>
</tr>
<tr>
<td>Average permeability</td>
<td>1,350mD</td>
</tr>
<tr>
<td>OBIP (project area)</td>
<td>3,302 e³m³</td>
</tr>
<tr>
<td>Oil viscosity @ 13C @ 60C</td>
<td>~25,000 cP ~600 cP</td>
</tr>
<tr>
<td>API oil gravity</td>
<td>10.3 - 10.8</td>
</tr>
</tbody>
</table>
Wabiskaw bitumen thickness

Type log cut offs:-
-<75 api gamma ray
->20 ohm resistivity
->27% porosity

OBIP under gas cap = 159,000 e³m³
Wabiskaw structural map
Wabiskaw stratigraphic cross-section

A

WBSK B VF
Depositional Edge

Regional WBSK

WBSK D Valley Fill

WBSK B Valley Fill

A'

Bottom water

MCMR
Horizontal production well 104/5-10

Producer drilled 15m below G/B interface:
- avoid hitting concretion
- avoid missing heated zone

Learnings:
- drill lower to optimize reserves recovery

Drilled in 2011 east of injector well at surface location 6-10
300m of horizontal leg landed 30m north of injector well and
~15m into heated zone
Drilling and completion

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Subsurface section 3

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Well layout

**Drilled 103/5-10-73-6W4 post burn vertical well September 2011**
- Drilled 11m northwest of 102/5-10-73-6W4
- Successfully cored 44m from top Wabiskaw to top of McMurray – no core
  - extensive core ad oil analysis program completed
  - core routine core analysis, SEM, XRD
  - oil API, viscosity, composition

**Drilled 104/5-10-73-6W4 horizontal producer well September 2011**
- Drilled 300m east-west horizontal section, landed 30m north of 100/5-10-73-6W4 injector well and 15m below Wabiskaw gas/bitumen interface
- Well equipped with 20 thermocouples in horizontal length
Completion

Installed tail pipe to toe
- divert hot crude to toe
- encourage warming near toe

Upsize artificial lift
- anticipate more influx as toe warms

Requirements under subsection 3.1.1 3c – wellbore schematics are included in the Appendix
Artificial lift

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Subsurface section 4

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Artificial lift

Artificial lift technology remains the same

- Progressive cavity pump (PCP), temperature tolerance of elastomer 150°C
- Lift capacity range: 34-50 m3/D
- Operating temperature range 44°C to 108°C
Artificial lift performance

Well produced from January 1, 2015 until well operations were suspended on February 13, 2015

- Significant volume of entrained gas ingested by the PCP
Instrumentation

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Subsurface section 5

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Instrumentation in wells

104/05-10-73-6W4/00

• Equipped with 10 thermocouples

Requirements under subsection 3.1.1 5a – wellbore schematics 5c and 5d are included in the Appendix
Thermocouple temp vs. depth
Scheme performance

Directive 54
Subsurface section 7

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Production history
Heated oil volume

Calculated using analytical geometry-based method
Combustion front heats bitumen by conduction in the shape of a sphere cap

- Thermally affected radius ~ 260m

Chemically affected

- 50,000m³

Thermal affected*

- 595,000m³
Historical oil quality

Original oil \(\sim 45,000\) cP at reservoir conditions (dead)

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Viscosity (cSt), temp (°C)</th>
<th>Asphaltenes (CS insoluble)</th>
<th>SARA, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25°C</td>
<td>35°C</td>
<td>50°C</td>
</tr>
<tr>
<td>1</td>
<td>6,469</td>
<td>2,608</td>
<td>781</td>
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<tr>
<td>2</td>
<td>7,510</td>
<td>2,111</td>
<td>853</td>
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<tr>
<td>3</td>
<td>5,006</td>
<td>2,103</td>
<td>652</td>
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<tr>
<td>4</td>
<td>9,073</td>
<td>2,488</td>
<td>925</td>
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<tr>
<td>5</td>
<td>8,013</td>
<td>2,185</td>
<td>844</td>
</tr>
<tr>
<td>6</td>
<td>7,954</td>
<td>2,112</td>
<td>1,022</td>
</tr>
<tr>
<td>7</td>
<td>7,763</td>
<td>2,971</td>
<td>860</td>
</tr>
<tr>
<td>8</td>
<td>8,276</td>
<td>3,050</td>
<td>884</td>
</tr>
<tr>
<td>9</td>
<td>8,271</td>
<td>2,410</td>
<td>928</td>
</tr>
<tr>
<td>10</td>
<td>5,889</td>
<td>1,646</td>
<td>662</td>
</tr>
<tr>
<td>11</td>
<td>8,442</td>
<td>2,338</td>
<td>894</td>
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<tr>
<td>12</td>
<td>7,180</td>
<td>2,449</td>
<td>926</td>
</tr>
<tr>
<td>13</td>
<td>6,270</td>
<td>3,583</td>
<td>737</td>
</tr>
</tbody>
</table>

No analysis conducted in 2015
### BS&W

<table>
<thead>
<tr>
<th>2014</th>
<th>BS&amp;W</th>
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<tbody>
<tr>
<td>Q1</td>
<td>2.0%</td>
</tr>
<tr>
<td>Q2</td>
<td>1.0%</td>
</tr>
<tr>
<td>Q3</td>
<td>1.0%</td>
</tr>
<tr>
<td>Q4</td>
<td>7.5%</td>
</tr>
</tbody>
</table>
Subsurface key learnings

**No casing gas pressure detected**
- Gases likely being pulled into tailpipe
- Observed decrease in pump efficiency
- No $\text{H}_2\text{S}$ detected

**Toe section contributions inferred based on observed thermocouple data**
- Jan 2015 ~ 10-15°C temperature increase observed

**EnCAID conductive heating effects observed following suspension of well operations**
- ~20°C temperature increase observed
Future plans

Directive 54
Subsurface section 8

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Future plans

Continue the following:

• Monitor downhole temperatures
• Suspension of AIDROH well operations
AER Dir 54 Section 3.1.2

Surface operations, compliance and issues not related to resource evaluation and recovery
Surface operations: Table of contents

- Facility overview/modifications
- Measurement and reporting
- Water, water disposal well and landfill waste
- Sulphur production
- Environmental issues
- Compliance statement
- Non-compliance discussion
- Future plans
Facility overview/modifications

Directive 54
Surface Operations section 1

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Site layout
Process flow schematic

Modification rationale
• Compliance with sour oil battery operations and license
• Sour rated vent
Facility performance 2015

Normal operations during production period
• January 1, 2015 to February 13, 2015

Suspended facility February 14, 2015
Gas usage

Usages are for blanket gases in sales oil tanks and incineration of produced sour gases

• Gas source Primrose plant sales
• Total usage 674 e³m³
Greenhouse gas emissions

<table>
<thead>
<tr>
<th>Month</th>
<th>2015 (tonnes)</th>
<th>2014 (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>29</td>
<td>46</td>
</tr>
<tr>
<td>February</td>
<td>12</td>
<td>64</td>
</tr>
<tr>
<td>March</td>
<td>-</td>
<td>91</td>
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<tr>
<td>April</td>
<td>-</td>
<td>101</td>
</tr>
<tr>
<td>May</td>
<td>-</td>
<td>109</td>
</tr>
<tr>
<td>June</td>
<td>-</td>
<td>112</td>
</tr>
<tr>
<td>July</td>
<td>-</td>
<td>115</td>
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<tr>
<td>August</td>
<td>-</td>
<td>78</td>
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<tr>
<td>September</td>
<td>-</td>
<td>23</td>
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<tr>
<td>October</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>November</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>December</td>
<td>4</td>
<td>30</td>
</tr>
</tbody>
</table>
Measurement and reporting

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Surface Operations section 2

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Measurement reporting

Field operations take daily tank readings, enter into daily tracking

Daily AIDROH tracking spreadsheet

Production Accounting Activities
1) BSW cuts are determined based on the Foster Creek labs analysis results. These are entered into EC.
2) Production is determined based on closing inventory-open inventory-receipts+ disposals.
3) Battery production and gas meter reports from EC used to created PRA uploaded file.
4) PRA submission is completed.

Field operations enter truck tickets into EC: total fluid volume with known average BSW

EC

Gas (vent, fuel, casing gas) meters loaded to EC via SCADA system

Receiving BSW from Foster Creek labs
Water, water disposal wells and landfill waste

Directive 54
Surface Operations section 5

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Water and waste disposal

No produced water

Produced bitumen volumes typically ~7% BS&W

No processing occurs on site

All produced volumes are trucked out for processing
Sulphur production

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Surface Operations section 6

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Sulphur production

No H2S detected after recompletion on Sept 2014

<table>
<thead>
<tr>
<th>2014</th>
<th>Sulphur Emission, Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>4.99</td>
</tr>
<tr>
<td>Q2</td>
<td>0</td>
</tr>
<tr>
<td>Q3</td>
<td>0</td>
</tr>
<tr>
<td>Q4</td>
<td>0</td>
</tr>
</tbody>
</table>
Environmental issues

**Directive 54**
**Surface Operations section 7**

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Environmental issues

No environmental issues occurred in 2015
Compliance statement

Directive 54
Surface Operations section 8

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Compliance confirmation

No non-compliance events occurred in 2015
Non-compliance discussion

Directive 54
Surface Operations section 9

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Compliance confirmation

No non-compliance events occurred in 2015
Future plans

Directive 54
Surface Operations section 10

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Future plans

Continue suspension of AIDROH well and facilities
Appendix
Wellbore schematic
Thank you