Cenovus EnCAID approval
#10440K
Performance presentation

Alberta Energy Regulator offices
Calgary
February 2016
Advisory

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Cenovus EnCAID* 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
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 completions
- Instrumentation
- Scheme performance
- Future plans
Scheme background

Directive 54
Subsurface section 1

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2015 annual performance presentation
Background

- The EnCAID project is an enhanced recovery scheme which displaces natural gas with combustion gases that are the result of combustion of residual bitumen in gas cap
Location map
Project overview

- Combustion of residual bitumen in gas cap
- Allows for displacement and re-pressurization of gas zone
- 100% Cenovus Energy Inc.
Geological/geoscience

Directive 54
Subsurface section 2

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## Summary of Wabiskaw gas properties

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depth</strong></td>
<td>465 TVD</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>5 m</td>
</tr>
<tr>
<td><strong>Average porosity</strong></td>
<td>~36%</td>
</tr>
<tr>
<td><strong>Average gas saturation</strong></td>
<td>~50%</td>
</tr>
<tr>
<td><strong>Average water saturation</strong></td>
<td>~30%</td>
</tr>
<tr>
<td><strong>Average bitumen saturation</strong></td>
<td>~20%</td>
</tr>
</tbody>
</table>
Wabiskaw stratigraphic cross-section
Drilling and completion

Directive 54
Subsurface section 3

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Well layout
Drilling and completion

- No new wells were drilled
- No recompletions
- No workovers

Requirements under subsection 3.1.1 3c – wellbore schematics are included in the appendix
Instrumentation

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Subsurface section 5

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Instrumentation in wells

**Observation Well: 102/05-10-73-6W4**
- Equipped with three piezometers
- Equipped with 10 thermocouples

**Observation Well: 100/6-10-73-6W4**
- Equipped with one piezometer
- Equipped with 10 thermocouples

Requirements under subsection 3.1.1 5a – wellbore schematics 5c and 5d are included in the appendix
Observation wells bitumen pressure
102/05-10-073-06W4 – Temp history
Observation well temperature
Scheme performance

Directive 54
Subsurface section 7

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## Project performance history

<table>
<thead>
<tr>
<th>Year</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>June - Ignition and start-up</td>
</tr>
</tbody>
</table>
| 2007 | Q1 – Nitrogen response at 00/14-9-73-6W4/00  
| | Q2 – Nitrogen response at 00/2-16-73-6W4/00, 00/11-15-73-6W4/00, shut-in 00/14-9-73-6W4/00 |
| 2008 | May – Nitrogen response at 00/1-17-73-6W4/00 |
| 2009 | Jan – Gas production shut-in due to 00/6-18-73-6W4/00 segregation repair  
| | Jun – Nitrogen response at 00/7-8-73-6W4/00  
| | Oct – Injectivity decrease observed |
| 2010 | Q1 - 00/5-10-73-6W4/00 injector stimulation treatment  
| | Q4 – Shut-in 00/1-17-73-6W4/00, 00/2-16-73-6W4/00, 00/11-15-73-6W4/00. Removal of 00/5-10-73-6W4/00 thermocouple string and perform pressure fall off tests |
| 2011 | Q1 - 00/5-10-73-6W4/00 injector stimulation treatment  
| | Mar/Apr – 00/11-15-73-6W4/00 flowed N₂ 85% |
| 2012 | Jul – Startup of 00/6-7-76-6W4/00  
| | Oct – Primrose sales volumes flowing to Caribou gas facility |
| 2013 | Feb - Startup of 00/6-6-73-6W4/00  
| | Mar - Shut-in 00/7-8-73-6W4/00 |
| 2014 | Dec – Startup 00/10-12-73-7W4/00 |
| 2015 | Jul– Startup 00/10-11-73-7W4/00 |
## Production/injection summary

### Production operations

<table>
<thead>
<tr>
<th>Operating for</th>
<th>Air injected</th>
<th>Bulk gas recovered</th>
<th>Formation gas recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;nine years</td>
<td>~ 240 e⁶m³</td>
<td>~ 165 e⁶m³</td>
<td>~ 144 e⁶m³</td>
</tr>
</tbody>
</table>

### Approved producers

<table>
<thead>
<tr>
<th>UWI</th>
<th>Status</th>
<th>UWI</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>00/06-05-073-06W4/0</td>
<td>Flowing ~ 42% N₂</td>
<td>00/02-16-073-06W4/0</td>
<td>Shut-in ~ 83% N₂</td>
</tr>
<tr>
<td>00/06-06-073-06W4/2</td>
<td>Flowing &lt;1% N₂</td>
<td>00/01-17-073-06W4/0</td>
<td>Shut-in ~ 85% N₂</td>
</tr>
<tr>
<td>00/06-07-073-06W4/2</td>
<td>Flowing ~ 2% N₂</td>
<td>00/10-11-073-07W4/0</td>
<td>Flowing &lt;1% N₂</td>
</tr>
<tr>
<td>00/07-08-073-06W4/0</td>
<td>Shut-in ~ 93% N₂</td>
<td>00/10-12-073-07W4/0</td>
<td>Flowing &lt;1%</td>
</tr>
<tr>
<td>00/11-15-073-06W4/0</td>
<td>Shut-in ~ 82% N₂</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
K3 pool production

10-11 Rate ~15 e3m3/d
IP Date July 2015

10-12 Rate ~23 e3m3/d

6-7 Rate ~15 e3m3/d

6-6 Rate ~8 e3m3/d

6-5 Rate ~12 e3m3/d

6-7 Rate ~15 e3m3/d

Injection Well

SI K1 or L3 Pool
History production
Voidage replacement ratio (VRR) - 2015

January and early August
• Steady air injection rates
• Minor downtime due to weather related events

Early August to late August
• Reduce air injection due to mechanical issues on a compressor

Late August to December
• Reduce air injection due to mechanical issues
### Voidage replacement ratio (VRR)

<table>
<thead>
<tr>
<th>Month</th>
<th>Monthly VRR</th>
<th>Cumulative VRR</th>
<th>VRR regulatory approved limit (Min monthly)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1.6</td>
<td>1.49</td>
<td>0.90</td>
</tr>
<tr>
<td>February</td>
<td>1.6</td>
<td>1.49</td>
<td>0.90</td>
</tr>
<tr>
<td>March</td>
<td>1.61</td>
<td>1.49</td>
<td>0.90</td>
</tr>
<tr>
<td>April</td>
<td>1.59</td>
<td>1.5</td>
<td>0.90</td>
</tr>
<tr>
<td>May</td>
<td>1.54</td>
<td>1.5</td>
<td>0.90</td>
</tr>
<tr>
<td>June</td>
<td>1.35</td>
<td>1.5</td>
<td>0.90</td>
</tr>
<tr>
<td>July</td>
<td>1.1</td>
<td>1.49</td>
<td>0.90</td>
</tr>
<tr>
<td>August</td>
<td>0.82</td>
<td>1.48</td>
<td>0.90</td>
</tr>
<tr>
<td>September</td>
<td>1.13</td>
<td>1.48</td>
<td>0.90</td>
</tr>
<tr>
<td>October</td>
<td>1.12</td>
<td>1.48</td>
<td>0.90</td>
</tr>
<tr>
<td>November</td>
<td>1.08</td>
<td>1.47</td>
<td>0.90</td>
</tr>
<tr>
<td>December</td>
<td>1.04</td>
<td>1.47</td>
<td>0.90</td>
</tr>
</tbody>
</table>
VRR performance

- AER VRR Targets:
  - Monthly Min 0.9
  - Annual Min 1.0
  - Cumulative 1.1 to 2.0

- 2015 YTD Average VRR ~1.48
- 2015 Cumm VRR ~1.47

- Monthly VRR over due to Production shut-in
- Maintenance
VRR history
K3 pool pressure
Historical: Temperature vs. Air Injection
Observation 6-10 well temperature
Composition of injected/produced fluids

- EnCAID does not currently sample air injected
- EnCAID captures gas samples for analysis on the schedule located to the right and monitors compositional changes for each well
- Cenovus samples selective wells on more frequent basis then required under Approval 10440K

<table>
<thead>
<tr>
<th>Location</th>
<th>Min Approval Sampling Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>00/6-10-73-6W4/2</td>
<td>Semi- annual</td>
</tr>
<tr>
<td>00/6-5-73-6W4/0</td>
<td>Semi- annual</td>
</tr>
<tr>
<td>00/6-6-73-6W4/2</td>
<td>Semi- annual</td>
</tr>
<tr>
<td>00/6-7-73-6W4/2</td>
<td>Semi- annual</td>
</tr>
<tr>
<td>00/7-8-73-6W4/0</td>
<td>Semi- annual</td>
</tr>
<tr>
<td>00/11-15-73-6W4/0</td>
<td>Semi- annual</td>
</tr>
<tr>
<td>00/2-16-73-6W4/0</td>
<td>Semi- annual</td>
</tr>
<tr>
<td>00/1-17-73-6W4/0</td>
<td>Semi- annual</td>
</tr>
<tr>
<td>00/10-11-73-7W4/0</td>
<td>Semi- annual</td>
</tr>
<tr>
<td>00/10-12-73-7W4/0</td>
<td>Semi- annual</td>
</tr>
<tr>
<td>00/6-18-73-6w4/0</td>
<td>Annual</td>
</tr>
<tr>
<td>00/10-36-72-7W4/2</td>
<td>Annual</td>
</tr>
<tr>
<td>00/11-17-73-6W4/0</td>
<td>Annual</td>
</tr>
<tr>
<td>00/14-9-73-6W4/0</td>
<td>Annual</td>
</tr>
</tbody>
</table>
Nitrogen response
Wabiskaw K-3 Pool material balance

Original Pressure – 2050 kPaa (300 psia)

Pressure Dec 03 = 662 kPaa or 96 psia
OGIP = 1129 $\times 10^6$ m$^3$ (39.9 Bcf)
Gas prod = 877 $\times 10^6$ m$^3$ (31.0 Bcf 77% RF)
Post-EnCAID RF ~ 85 - 87%

Dec/2015
Cum Prod 1,042 $\times 10^6$ m$^3$ (36.9 bcf)
RF 92%

Pre-EnCAID  →  EnCAID
Subsurface key learnings

• Presence of more than one oxidation front indicates that there is fuel remaining in the region swept by the combustion front
  • fuel remaining in the region swept by the combustion front
  • could be either residual oil left behind first oxidation front, or re-saturation with oil from adjacent rock or, possibly from flammable vapor produced from the oxidation and cracking reactions
• Strong correlations between air-injection rate and temperature changes
  • first oxidation zone at the bottom of the gas cap was truncated by a reduction in injection rate
  • increase in injection rate performed in early 2013 resulted in ignition and combustion of the top of the bitumen
Future plans

Subsurface section 8

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Future plans

- No changes in overall recovery strategy are planned at this time
AER Dir 54 Section 3.1.2

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

1. Facility overview/modifications
2. Measurement and reporting
3. Environmental issues
4. Compliance statement
5. Future plans
Facility overview/modifications

Directive 54
Subsurface Operations section 1

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Site Layout
Process flow schematic
Plant performance - 2015

**January to early August**
- Steady air injections
- Some weather related reductions

**August 5 to August 22, 2015**
- Reduced air injection rate

**August to year end**
- Resumption of steady air injections

**Facility is operating as expected**
Gas usage

Usage is as fuel gas for air compressor operations

- Gas source Primrose plant fuel gas
- Total 2015 usage 1,907 e³m³
**Green house gas emissions**

<table>
<thead>
<tr>
<th></th>
<th>2015 (tonnes)</th>
<th>2014 (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>522</td>
<td>477</td>
</tr>
<tr>
<td>February</td>
<td>439</td>
<td>472</td>
</tr>
<tr>
<td>March</td>
<td>478</td>
<td>519</td>
</tr>
<tr>
<td>April</td>
<td>461</td>
<td>498</td>
</tr>
<tr>
<td>May</td>
<td>482</td>
<td>521</td>
</tr>
<tr>
<td>June</td>
<td>456</td>
<td>504</td>
</tr>
<tr>
<td>July</td>
<td>455</td>
<td>405</td>
</tr>
<tr>
<td>August</td>
<td>335</td>
<td>300</td>
</tr>
<tr>
<td>September</td>
<td>437</td>
<td>326</td>
</tr>
<tr>
<td>October</td>
<td>457</td>
<td>511</td>
</tr>
<tr>
<td>November</td>
<td>413</td>
<td>484</td>
</tr>
<tr>
<td>December</td>
<td>431</td>
<td>538</td>
</tr>
</tbody>
</table>
# Surface gas migration

<table>
<thead>
<tr>
<th>Year</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>No development yet at EnCAID site, set base line.</td>
</tr>
<tr>
<td>2006</td>
<td>LEL disappeared when went to &quot;Methane elimination mode&quot; which is standard practice for these tests.</td>
</tr>
<tr>
<td>2007</td>
<td>LEL detection in &quot;Full Gas Detection Mode&quot; disappeared in &quot;Methane Elimination Mode&quot; suggesting swamp gas, the report noted clay cap over most of the sites could be trapping methane from organic peat decomposition.</td>
</tr>
<tr>
<td>2008</td>
<td>Collected low pressure gas samples for analysis at 5-10 &amp; 11-15. Additional testing confirmed biogenic gas.</td>
</tr>
<tr>
<td>2009</td>
<td>SDS concluded that in their opinion it is a biogenic gas/swamp gas problem. Single Sample showed above 100% LEL came from wet, sloppy and drilling mud type of soil west of well center</td>
</tr>
<tr>
<td>2010</td>
<td>SDS opinion it is a biogenic gas/swamp gas problem. 2010 LEL readings less then 2009 LEL readings. No samples taken.</td>
</tr>
<tr>
<td>2011</td>
<td>SDS opinion is that gas detected through field screening is swamp gas from the organic material beneath the well site. The gas sample collected contained insufficient hydrocarbons for carbon isotope analysis.</td>
</tr>
<tr>
<td>2012</td>
<td>No testing undertaken.</td>
</tr>
<tr>
<td>2013</td>
<td>SDS considered two samples to be inconclusive as soil around the well center were highly saturated and swampy. No sample was submitted for isotope analysis.</td>
</tr>
<tr>
<td>2014</td>
<td>SDS considered it was a biogenic gas/swamp gas problem.</td>
</tr>
<tr>
<td>2015</td>
<td>No gas migration, with detected gas being biogenic gas/swamp gas.</td>
</tr>
</tbody>
</table>
Surface facility key learnings

- Safe operation of production and injection wells
- Geographical location provides challenges for instrumentation operations utilizing solar panels during the winter season
- Purity of injection gases plays key role in maintaining injectivity
- Marginal economics to operate in today's pricing environment
Measurement and reporting

Directive 54
Surface Operations section 2

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Measurement reporting

Field Operations record daily flow variable and volume for air injection and compressor fuel usage

EnCaid Daily Volume Report Spreadsheet

Gas analysis - Maxxam

Production Accounting Activities
1) PA updated gas analysis in PAS.
2) PA enter air volume and fuel usage volume from EnCaid Daily Volume Report into PAS EnCaid injection facility.
3) Well production PVR data upload to PAS.
4) PAS generates PRA submission.
5) PA manully updated the gas fuel usage into PRA.

Gas well gas meters loaded to PVR via SCADA system

PVR
Environmental issues

Directive 54  
Subsurface Operations section 7

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Environmental compliance

- No environmental non-compliance events occurred since the last performance review
Compliance statement

**Directive 54**
**Subsurface Operations section 8**

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Compliance confirmation

- August 26, 2015 notice sent to AER that Cenovus may not meet the VRR of 0.9 for August as per condition 12 of Approval# 10440J
  - AER response acknowledging receipt received August 26, 2015
  - no further action required from AER on this matter

- No other non-compliance events occurred since the last performance review
Future plans

Directive 54
Subsurface Operations section 10

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Future plans

• No major initiatives or plans that may require submission of an application are being contemplated at this time
• No changes to overall plant design or amendments are anticipated at this time
• Operate the project until it is economic
Appendix
Gas composition 00/1-17-73-6W4/0
Gas composition 00/2-16-73-6W4/0
Gas composition 00/6-5-73-6W4/0
Gas composition 00/6-6-73-6W4/0
Gas composition 00/6-7-73-6W4/0
Gas composition 00/7-8-73-6W4/0
Gas composition 00/11-15-73-6W4/0
Gas composition 00/10-11-73-7W4/0
Gas composition 00/10-12-73-7W4/0
Gas composition 00/14-9-73-6W4/0
Gas composition 00/6-18-73-6W4/0
Downhole instrumentation layout
100/05-10-073-06W4 wellbore schematic
102/05-10-073-06W4 wellbore schematic
Thank you