Application of Propane Based Hydraulic Fracturing in the McCully Gas Field

Presented at:
2011 SPE Unconventional Gas Conference
14-16 June 2011

SPE 144093
Don LeBlanc, Eastex Petroleum Consultants Inc
Tom Martel, Dave Graves, Corridor Resources Inc
Eric Tudor, Robert Lestz, Gasfrac Energy Services Inc
Introduction

• Up to 2009, 91 water-based hydraulic fractures were placed in 32 wells in the McCully field ranging in size from 9 tonnes to 100 tonnes

• There have been issues with initial fracture conductivity

• Unbroken fracture gel has been recovered from a number of wells, more than 1 year after the fracture was placed

• In 2009, 9 propane (LPG) based hydraulic fractures were placed in 4 wells in an attempt to improve flowback performance and fracture characteristics

• Propane fractures have improved fracture clean-up, fracture characteristics and well productivity
McCully Field
McCully Geology

- Hiram Brook sands (~0.5 Tscf in place) overlie the Frederick Brook shale (~67 Tscf free gas in place)
- Carboniferous
- Lacustrine environment
McCully Development Issues

- Tight, low perm stacked sands (A to G)
- High pressure (0.58 psi/ft) low temperature reservoir: 40°C @ 2250m, 104°F @ 7380 ft
- Desiccated reservoir (avg $S_w \sim 20\%$)
- Highly stressed

<table>
<thead>
<tr>
<th>McCully Reservoir Parameters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Depth</td>
<td>1800m</td>
</tr>
<tr>
<td>Gross Thickness</td>
<td>Up to 870m</td>
</tr>
<tr>
<td>Net Pay</td>
<td>Up to 95m</td>
</tr>
<tr>
<td>Temperature</td>
<td>40°C - 60°C</td>
</tr>
<tr>
<td>Porosity</td>
<td>4% - 8%</td>
</tr>
<tr>
<td>Water Saturation</td>
<td>&lt;10% - 30%</td>
</tr>
<tr>
<td>Permeability</td>
<td>0.01mD - 1.8mD</td>
</tr>
<tr>
<td>Reservoir Pressure</td>
<td>20 MPa - 35 MPa</td>
</tr>
</tbody>
</table>

McCully Frac Gradients
Historical Water Fractures

- Prior to 2009, wells were fracture stimulated with water-based, cross linked polymer gels.
- Stimulation sizes over 50 tonnes did not appear to significantly improve gas rate.
Historical Water Fractures (2)

- Water production is an on-going issue at McCully
- Ultimate water recovery is low which impacts fracture clean-up/flow effectiveness
Flowback Analysis

- To evaluate and compare fracture clean-up response, dimensionless type curves were developed.
- Dimensionless parameters are $J_D$ (productivity index) and $t_D$ (time) and FCD (fracture conductivity).
Water Fracture Performance

- The initial tests of the water fractures appeared to indicate that the fracture was ineffective (FCD~0)
- Subsequent tests showed improvements in fracture conductivity
- In almost all cases, it required three tests (flow / shut-in sequences) before FCD was maximized
- This result was also observed for wells with multiple water fractures
LPG Fracture Concept

- After the propane gel breaks and reservoir gas is produced, the liquid propane flashes and all of the fracturing fluid is recovered.
- This results in a significantly improved effective fracture length and conductivity.
LPG Fracturing

- Data / Satellite Van
- Chemical Van
- Pumping units
- Fire Truck
- Test Package
- Site Control
- LPG Storage Tanks
- Blenders

Don LeBlanc
SPE 144093: Application of Propane Based Fracture Stimulation
2009 LPG Fractures

- Nine LPG fractures were placed in 4 wells
- Flowback of the propane fracture stimulated wells recovered 100% of the load fluid
- Production performance increased as size increased (note - requires additional data)
Propane Fracture Performance (1)

- Flowback of the propane fractured wells flowed liquid propane for up to 24 hours
- This propane was heated, flashed and flared
- In all cases, 100% of the propane was recovered
Propane Fracture Performance (2)

- The initial test of the propane fractured well exhibited a maximum value for FCD.
- All subsequent tests confirmed the maximum FCD.
- Liquid propane was recovered during the first 24 hours after which gas was produced.
• Testing of a propane fracture of the Frederick Brook shale performed similarly to the Hiram Brook sand tests
The propane fractures had microseismic events over an area of 12-15 acres.

A water fracture had microseismic events over an area of 3-5 acres.

Note: Very sparse data set (validity?)
Test analysis was performed to evaluate effective fracture half length, $x_f$.

The results show that effective $x_f$ for the propane fractures was significantly higher than for equivalent sized water fractures.

Note – all values in meters
Propane Fracture Forecast Uplift

• Based on observations and derived parameters, a propane fracture should deliver an initial doubling of gas rate over a water fracture.

• Note – this is only applicable to McCully!

![Forecast Post-Fracture Performance](image1)

![Forecast Propane Fracture Rate Uplift](image2)
Summary & Conclusions

• Clean-up and initial well performance was significantly enhanced using gelled propane fracture stimulation

• Fracture conductivity was maximized within 24 hours of flowback

• Effective fracture length was doubled

• 100% of the propane was recovered within 10 days

• Initial uplift (for McCully) was a factor of 2 (over water fractures)
Thank You!