Application and Modelling of Advanced Completion Technology, to Improve the Performance of EOR in Unconventional Oil Reservoirs

Mike Smith

7th May 2019
Problem Background

• Reservoir and fracture heterogeneity causes large variations in fracture behaviour

• Huff & Puff EOR injects gas to soak and create contact between injected gas and oil, and can improve productivity

• Heterogeneity can cause large variations in this oil – gas contact, also affecting hydrocarbon PI

• The longer the soaking period the better, but it is costly
AIM:

Build a heterogeneous fracture model to display the positive effect of adding Huff & Puff EOR and AICD’s to fracture zones
Model Specification

Box model based on a field in North America

- Tight oil reservoir
- ~200k active grid blocks
- IJK: 141,141,10
- IJK block size (ft): 100x100x3
- Multi-phase compositional
- Heterogeneous Ø/K
- 1 horizontal well – producer & injector
- CO2 huff & puff
Model Building Workflow

STAGE 1
Static Heterogeneity

STAGE 2
Fracture Heterogeneity

STAGE 3
Well Design & Integration
Stage 1 – Static Heterogeneity

- **Import pre-built model**
  - Full dynamic model
  - Homogeneous static properties

- **Add pseudo logs**
  - Random porosity log generated
  - Log blocked into grid

- **Property interpolation**
  - SGS
  - Simple isotropic variogram

- **Property correlation**
  - Poroperm correlation
  - PERMX/Y/Z

- **Poroperm correlation formulae**
  - $\text{PERMX} = \exp(15 \times \text{Poro}) \times 0.05$
  - $\text{PERMY} = \text{PERMX}$
  - $\text{PERMZ} = \exp(15 \times \text{Poro}) \times 0.035$
Stage 1 – Static Heterogeneity
Stage 2 – Fracture Heterogeneity

- Varied fracture length
- Varied fracture spacing along wellbore

<table>
<thead>
<tr>
<th>Number of fractures</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fracture 1 half length</td>
<td>200ft</td>
</tr>
<tr>
<td>Fracture 2 half length</td>
<td>350ft</td>
</tr>
<tr>
<td>Fracture 3 half length</td>
<td>150ft</td>
</tr>
<tr>
<td>Fracture 4 half length</td>
<td>500ft</td>
</tr>
<tr>
<td>Fracture 5 half length</td>
<td>150ft</td>
</tr>
<tr>
<td>Fracture aperture</td>
<td>0.19685in</td>
</tr>
</tbody>
</table>
Stage 3 – Well Design & Integration

Well Structure
- Casing to top of reservoir. Open hole thereafter
- Tubing from surface to TD
- 5 AICD’s at each fracture point
- Packers at end of casing and between AICD’s

Well Segments
- Single tick box to auto-generate segments to well
- 2 segments per grid block along the well

Reservoir model integration
- IMPORT_PROJECT keyword links well project to model
- Bypasses industry standard well definition keywords
Results Analysis

Frac only
Frac + H&P
Frac + H&P + AICD
Results Analysis & Summary

- Huff & Puff EOR is an efficient method of improving oil production in this tight reservoir.
- AICD addition aids oil rate throughout the H&P cycle, as well as post-cycle.
- AICD’s located at the fracture keep injected gas in the reservoir to increase soaking period.
- Increased gas-oil contact causes a decrease in oil viscosity and improved oil rate, syn and post-cycle.
- This concept was modelled using a user-friendly method, integrating the well as a project into the reservoir model and bypassing industry standard well definition keywords.
The Next Step...THP Control

Creating lift curves to control by THP

- During the well design process, wellbore fluids were defined
- Lift curves were then generated, linking the reservoir up with the surface
- THP control will XXXXXXXXX
The Next Step...LGR Fractures

Populating fracture zone and stimulated rock volume with LGR

• LGR fractures will increase model heterogeneity
• Fracture zone (FZ) & stimulated rock volume (SRV) is geometrically defined and LGR populated
• FZ, SRV and therefore LGR can be populated in any direction, not just parallel/perpendicular to wellbore
The Next Step... Uncertainty

The sensitivity parameters are endless!

HOPE IN THE FACE OF UNCERTAINTY.

WE SHALL OVERCOME!
Thank you for listening!

Integrated static and dynamic modelling from reservoir to surface