2014 EIA Energy Conference
Tight Oil Production Trends

Technology On the Horizon & Over the Horizon

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Schlumberger

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Schlumberger is a provider of hydraulic fracturing services that

• develops and provides fracture fluid chemicals
• designs and executes hydraulic fractures using its own personnel and equipment

The opinions expressed here are my own and do not necessarily reflect the views of Schlumberger.
Status

Technical Improvements Focused on Efficiency & Cost Reduction

- Easy to measure – and reward
- Pad drilling has been a game-changer and has swept the industry
  → Fewer rigs + more production
- Equipment design now emphasizes reliability over mobility
- Supply chain managers are gods
  “Amateurs talk strategy; professionals study logistics”

Production Enhancement Has Taken a Back Seat

- Harder to quantify
- Initial production is an early indicator, but declines quickly
- EUR uncertain due to poorly-understood reservoir dynamics
## The Pathetic Performance of Tight Oil Wells

*rough numbers*

<table>
<thead>
<tr>
<th></th>
<th>Annual Decline Rate</th>
<th>Recovery Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Oil Wells</td>
<td>5%</td>
<td>50%</td>
</tr>
<tr>
<td>Tight Oil Wells</td>
<td>50%</td>
<td>5%</td>
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</tbody>
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Recovery Methods

Conventional Oil Recovery

Primary Recovery
- Lithostatic Pressure
- Solution Gas Drive
  - Artificial Lift

Secondary Recovery
- Pressure Maintenance
  - Water Drive
- Gas Drive

Water Flood

Tertiary Recovery
- Carbon Dioxide
- Steam
- Miscible Solvent
- Surfactant
Recovery Methods

Tight Oil

Primary Recovery

Lithostatic Pressure

Solution Gas Drive

Artificial Lift

Recovery Methods
Tight Oil
Why Secondary Recovery Doesn’t Work

Pressure Maintenance Doesn’t Work: Tight Oil Plays Not Buoyancy Driven

Water Flood Doesn’t Work: Formation Permeability Too Low
While oil production from CO$_2$-EOR has steadily increased, its growth has slowed in the past few years. This is due primarily to limits on accessible, affordable supplies of CO$_2$.

Kuuskraa & Wallace
O&GJ, 5 May 2014

<table>
<thead>
<tr>
<th>CO$_2$ Huff &amp; Puff</th>
<th>Steam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Many academic/theoretical publications</td>
<td>Unlikely to be economic when oil is 3% of rock volume</td>
</tr>
<tr>
<td>No tertiary recovery field tests (to my knowledge)</td>
<td></td>
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<tr>
<td>The oil industry lives in a CO$_2$-constrained world</td>
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<table>
<thead>
<tr>
<th>CO$_2$-EOR Projects</th>
<th>156</th>
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<tbody>
<tr>
<td>Oil Production kb/d</td>
<td>300</td>
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<tr>
<td>CO$_2$ Natural Sources</td>
<td>5</td>
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<tr>
<td>CO$_2$ Natural mmcf/d</td>
<td>2.8</td>
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<td>CO$_2$ Industrial Sources</td>
<td>12</td>
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<tr>
<td>CO$_2$ Industrial mmcf/d</td>
<td>0.7</td>
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</table>

“While oil production from CO$_2$-EOR has steadily increased, its growth has slowed in the past few years. This is due primarily to limits on accessible, affordable supplies of CO$_2$.”

Kuuskraa & Wallace
O&GJ, 5 May 2014
Possible Routes to Production Enhancement

**Refrac**

- Effectiveness is debated
- Publications seem to be “success-biased”
- Will work in selected situations to solve known problems
- New technology available to improve process (e.g. diversion)
- Local supply chain has to be restarted
- Current strategy is to drill a new well elsewhere

Vincent, SPE 134330 after Cipolla, 2005
In-Fill Drilling

- Another raging debate
- Pressure interference at 1000 ft, but SRV radius < 300 ft
- A few tests have been performed
In-Fill Drilling vs Proppant Transport

- We are fracturing 1000 foot wings to place proppant a few hundred feet
- Wastes water, sand, chemicals, and time.
- A problem technologists love to work on
  - → fiber fracs, clever pumping schedules, proppant modification
- Potentially a cheap alternative to in-fill drilling
- Look for incremental improvements
Tight Oil is Competitive with Other High-Price Resources and has the Greatest Potential for Cost Reduction.
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