CO₂ as a Commodity for Realizing the Potential in Unconventional Production Strategies of Conventional Reservoirs

September 26th, 2019
What does that long title mean?

• It means,
  - Injecting CO\textsubscript{2}, or a mix of CO\textsubscript{2} and produced gas, into areas of horizontal well development in conventional reservoirs (outside of conventional waterflood development)
  - Mobilizing a secondary oil bank not realized from frac’ing methods
  - Sequestering CO\textsubscript{2} long term

• Two options for implementation
  - Producer huff-and-puff
  - Dedicated CO\textsubscript{2} injectors

• Successful projects already underway in unconventional plays:
  - Eagleford (EOG, Marathon) – produced gas huff-and-puff
  - Bakken – (Hess) – produced gas huff-and-puff
  - Permian Wolfcamp – (Oxy) – CO\textsubscript{2} huff-and-puff
What is the Horizontal San Andres Play?

- Drilling horizontal wells outside of traditional anticlinal structures in the “fairways” between existing fields
- Use unconventional completion strategies to produce
- San Andres reservoir has conventional rocks properties
  - Porosity in the 6-8% range
  - Millidarcy permeability
- Water disposal is critical to economic success
  - High fluid volumes, with a 5-20% oil cut

Source: Melzer & Trentham, SIPES, April 2016
What is the Horizontal San Andres Play?

Imagine an ROZ pore space....

Movable hydrocarbons have been swept leaving water plus residual oil molecules clinging to the rock → The resultant pressure of the incompressible water in the pore is so great that the compressible oil molecules can’t move

For oil to mobilize, the pore must first be de-pressurized resulting in high initial water production

With some of the incompressible water removed, oil molecules expand, coalesce, & release from the pore surface → The well then produces both oil and water

*A horizontal well with a multi-stage frac expedites this de-pressuring process

Dec. 2017, CO₂-ROZ conference, Midland, TX
What is the Horizontal San Andres Play?

• As of May 2019:
  - > 40 companies
  - > 540 wells
  - > 46,000 BOPD

• Primarily focused in Yoakum, Gaines, Cochran and Andrews County

• Wide range of companies involved, small independents to super majors

• Low operating costs (~$10/BO) if you have water disposal
Why the Horizontal San Andres Play?

- **San Andres dolomite**
  - Most widely CO$_2$ flooded rock in the world
  - Proven response to CO$_2$ injection
  - Proven ability to sequester gas
  - Demonstrated results flooding the ROZ fairway (KM-Tall Cotton Field)

- **Permian Basin:**
  - Has the knowledge, expertise and technical ability to implement EOR projects
  - Has the infrastructure for distribution
Horizontal San Andres Characteristics

Well Characteristics

- **Depth:** ~5500’
- **Length:** 5000’-7500’
- **Frac Stages every 200-300’**
- **Smaller proppant loads than unconventional plays**
- **D&C costs of $2.5-$3.0MM/well**
Horizontal San Andres Characteristics

- Wells are typically developed:
  - North-South
  - 4-6 wells per section
  - Frac heights ~100ft
- EURs of 150-500+ MBO
- Ultimate recoveries in the 5-10% OIP range
- Waterflood is not an option
- CO₂ injection can recover another 25-30% of the OIP!
Size of the Prize (big picture)

- Roughly ~4MM acres of San Andres fairway (light blue)

- Assuming:
  - $\Phi = 6\%$
  - $S_o = 40\%$
  - $h = 100$ ft

  $OIP = 59,580 \text{ MMBO}$
  $REC. \text{ OIL} = 14.9 \text{ MMMBO}$!

- At a net utilization rate of 6 MCF/BO, 89 TCF of CO$_2$ would be needed

Melzer & Trentham, SIPES, April 2016
Implementation: Option #1

CO₂ “huff-n-puff”

• Pros
  - Use existing wellbores
  - Exploitation of known flowpaths
  - Ability to use produced gas as well that may be currently flared
  - Existing EOR projects in Eagleford & Bakken show ~30%-50% type uplifts in EUR with natural gas (CO₂ should do better)

• Cons
  - Shut in oil production for the injection and soak period (up to 30 days)
  - Requires multiple cycles
  - Requires sizeable upfront CAPEX for compression
Implementation: Option #2

Dedicated CO₂ Injection

• Pros
  - Don’t have to take producers offline
  - Mobilization of a larger area of oil-bearing rock
  - Ability to use produced gas as well that may be currently flared

• Cons
  - Requires sizeable upfront CAPEX to drill dedicated injectors (horizontal or vertical)
  - Requires sizeable upfront CAPEX for compression
  - Requires continuous, reliable CO₂ supply
  - Will sweep efficiency be detrimentally impacted by the fracture network created?
Horizontal San Andres CO₂ Potential

• Why isn’t it already on-going?
• Several obstacles to implementation
  - Majority of current operators are small in size or private equity backed
  - Long-term vision to invest tens of millions of dollars in a long payout project
  - Optimistic forecast of long-term oil prices (can’t hedge until the oil shows up)
  - Constrained CO₂ supply in the Permian
    • Natural supplies are primarily accounted for through long-term contracts
    • Anthropogenic capture needs to fill the gap (at an economic rate)
Summary

• Billions of barrels of recoverable oil lies in the San Andres formation of the Permian Basin

• The stranded oil can, and has been, recovered through CO₂ injection and gas can be sequestered

• The horizontal San Andres play has 500+ wellbores available for implementation close to existing CO₂ pipeline networks

• Several issues like CO₂ supply, capital allocation need to be resolved for the next phase of the play to get underway, ultimately oil price (or carbon credits) will be the catalyst.
Questions?