A New Era: Efficient Tight Oil Development in US

Iwan Harmawan
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Outline

A New Era: Efficient Tight Oil Development in US.

• Background & Objective of the presentation

• Development of Tight Oil (Unconventional Play) in US
  • What’s tight oil (definition)? Location/Fields?
  • Key challenges: Low productivity/Rapid Decline/Distinctive Flow Regime vs. Conventional Oil

• Technology & Operational advancement in last 5-years
  – Field Case Example: how technology influences commerciality of unconventional play?
  – Technology: Old vs Recent
    – Operational efficiency

• Future Outlook: Where do we go from here?

• Conclusion
Background & Objective Presentation

This presentation is an attempt to elaborate what has changed lately in oil industry.

Recent changes in Oil Industry
– Downturn in the oil industry since 4QTR 2013. Mostly because of over-supply/demand reduction.
– Coincide with tight oil/gas development.

Why Tight Oil Development is so efficient?
– Advancement in reservoir characterization
– Advancement in hydraulic fracturing technology
– More Infill drilling – more wells can be drilled from same well-pad (i.e. efficient drilling campaign)
– More efficient supply-chain/logistic

*) www.macrotrends.net (crude-oil-price-history)

*) SPE 146876 – C.L Cipolla at al
What is Tight Oil Development?

Unconventional oil is petroleum produced or extracted using techniques other than the conventional (oil well) method (https://en.wikipedia.org/wiki/Unconventional_oil)

The Alberta Energy Regulator refers to unconventional oil as tight oil: oil found in low-permeability rock, including sandstone, siltstone, shale, and carbonates (https://www.aer.ca/about-aer/spotlight-on/unconventional-regulatory-framework/what-is-unconventional-oil-and-gas)

- Various places/fields in US
- Required different completion technique
- Permeability & porosity are significantly lower:
  - 0.1 mD – 0.0001 mD
  - 3 – 12% porosity
  - 25-40% of Sw
  - 45 deg API oil
  - Low recovery
- Complicated flow regime

*) SPE 161137 Nelson, 2009
Key Challenges in Tight Oil Development

– **Extremely low permeability**
  - Require stimulation technology
  - Stimulated Reservoir Vol. Concept

– **Rapid decline**
  - 60% decline rate in 1st year
  - Stabilized at low rate for long time

– **Complicated flow behavior**
  - As function of wellbore geometry

– **Not much production history for analog**
  - Technology wasn’t available prior to 2005

– **Long term forecasting is challenging**
Advancement in Technology

- **Rapid advancement in hydraulic fracturing**
  - Number Simulation Stages
  - Bigger volume & different proppant & different fluid.
  - Longer lateral
  - Cheaper cost/completion (optimum supply chain strategy)

- **Improved reservoir characterization**
  - More lab measurements
  - Coupling geology/reservoir quality + completion design allows significant improvement on prod-forecasting

- **Infill Drilling & Well-Pad Technology**
  - Sharing 1 well-pad for multiple well – ability to do batch drilling (cost efficiency)
  - Lower CAPEX/Operational Cost; multiple wells can share one processing facility

- **Data Mining** (cluster analysis + prod trend + multi-variate regression)

*) Avalanche Journal
Field Example Bakken: Technology - What has changed? _Rapid production growth_

- Jan 2014: North Dakota prod reached ~ 1 million BOPD
- 2011: North Dakota overtakes Alaska as 2nd highest producing states
- 2008: average rig count is > 75 (prod: 175 k BOPD)
- 2004: early hydraulic fracturing technology
- 2000: First Horizontal well in the Bakken

- 1987: Beginning of Upper Shale Bakken
- 1984: Vertical well in Elm Coulee
- 1955: Amerada Hess drills first oil vertical well in Tioga
- 1927: Oil Discovered in Cedar Creek Anticline

Field Example Bakken: Technology - What has changed?

Ability to be more efficient on applying certain technology

- Frac Size
  - 2004-2008: Single stage/8 stages
  - 2008-2011: Multiple-stages (up to 32)
  - 2012 – Now: Multiple stages (> 50 stages)

- Various different applications are being applied in various places
  - Plug and Perf: Cemented Liner (more proppant, more stages, more stimulated area)
  - Sleeves (time saving, continuous pumping, less expansive)
  - Hybrid between two (e.g. half sleeves + half Plug and Per)
  - Every company has different preference


*) Sliding Sleeves completion
Field Example Bakken: Subsurface- What has changed? **Ability to Identify Best Location & Better Completion**

- Evolving from simple Stimulated Reservoir Volume (SRV) Concept to a multi-disciple/integrated modeling (coupled model – from geology/reservoir, geomechanic, completion design) → ability to optimize completion design
- Data Mining: Statistical analysis (more production history) → ability to identify best location
Where Do We Go from Here?

- Tight oil development has changed the future of oil industry
  - Better reservoir characterization
  - Technology is accessible and cheaper
  - Technology is evolving faster and becoming more efficient
  - Low Risk – e.g. compared to (Ultra) Deepwater development
  - Cheaper overall CAPEX & Operating Cost (ref to EOG earning reports)

- This is NOT new situation (low oil price environment has happened before)
  - Industry need to quickly adapt and make changes for future growth.
  - Restructuring/re-staffing/refocusing their portfolios – reevaluating/re-optimizing technologies for offshore application
  - Maintaining base-production/improving reliability & uptime

*) www.macrotrends.net (crude-oil-price-history)
Conclusion (?)

- Rapid advancement in Tight Oil Development. Industry (e.g. many operators) has overcome the hurdles and is able to develop this tight oil more efficiently
  - However, this has contributed to situation where there is over-supply in Crude Oil inventory
  - Current environment: Low Oil Price

- Low Oil Price: Difficult times for many Operators AND Oil & Gas Professionals
  - However, historically industry would adapt to new environment. Hence, expect another cycle of growth ‘soon’.
  - There’s light at the end of the tunnel!!