El Corcobo Norte Field (Neuquén Basin, Argentina) was selected for a polymer injection pilot that started early in 2012. Being an unconsolidated sandstone, medium-heavy oil reservoir, the field was developed through cold production with sand (CHOPS) and with waterflooding as a main drive. After EOR technologies screening, two processes were selected to improve oil recovery in El Corcobo Norte Field: ASP and Polymer flood. Polymer injection pilot has been running for five years and remains under evaluation. However, information already obtained from the project is considered reliable enough to propose an expansion phase for this project. The current presentation will focus on the design, execution and evaluation of a polymer injection pilot, as well as an overview of the field expansion.
Polymer Injection Project in an Unconsolidated Sandstone in Neuquén Basin, Argentina

Federico Hochenfellner, Pluspetrol S.A.
Agenda

- Introduction: El Corcobo Norte Field
- Polymer Pilot Design
- Pilot Operation
- Pilot Results
- Summary
- Next Steps
El Corcobo Norte Field

Reservoir Characteristics
- Basin Edge
- Coastal plain fluvial sandstones
- Stratigraphic Trap
- Low angle truncation
- Lateral facies changes
El Corcobo Norte Field

Reservoir Characteristics
- Shallow reservoir (2150ft)
- Unconsolidated sandstone
- Good lateral continuity - Up to 60ft of net pay
- High porosity (30%) and permeability (0.5 - 4.0D)
- Strongly water-wet rock
- Low reservoir temperature (38ºC / 100ºF)

Fluid Characteristics
- Medium-heavy oil (160 – 300 cP live Oil; 18 ºAPI)
- Pb: 330 psi / Rsi: 7 m³/m³
- High Total Acid Number (TAN > 4mg KOH/gr oil)
- Moderate formation water salinity (46,000 ppm TDS)
El Corcobo Norte Field

Development & Field Operation

- Production started in 2005
- Waterflooded from early beginning (2007)
- Inverted seven spot patterns (20 acres well spacing)
- Sand production/management
  - Wormhole generation
  - Injector – Producer “Short Circuit” – Main challenge
- 650 Producers Wells
- 350 Injector Wells
- Production:
  - Liquid rate: 200000 bbl/d
  - Oil rate: 28000 bbl/d
  - Injection rate: 195000 bbl/d
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Polymer Pilot Design

- **6 Inverted Seven Spot Patterns**
  - 6 Injector Wells
  - 22 Producer Wells
  - 20 acres well spacing (950ft between wells)

- **Initial Production Conditions**
  - Liquid Rate: 8,500 bbl/d
  - Oil Rate: 1,400 bbl/d
  - Water Cut: 84%
  - Dedicated Production Facilities
Polymer Pilot Design

- Polymer:
  - Standard HPAM
  - High molecular weight (~20MMDa)
- Water: Softened Fresh Water
- Polymer concentration: 550ppm
- Viscosity Target: ~20 cp (@ 7 1/S, 38°C)

- Total injection Rate: 5200 bbl/d:
- Operational capabilities:
  - Injection rate adjusted well by well (Automatic control)
  - Polymer concentration selected well by well
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- Introduction: El Corcobo Norte Field
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- Pilot Operation
  - Polymer Viscosity
  - Polymer Injection Rate
- Pilot Results
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Pilot Operation

- Polymer viscosity
  Target: 20-25 cP
Pilot Operation

- Water viscosity
  Target: 20-25 cP

Polymer supply issues
**Pilot Operation**

- **Water viscosity**
  - Target: 20-25 cP

**Polymer supply issues**

**Softening plant start up**

![Graph showing water viscosity and polymer concentration over time](image)

- *Viscosity [cP @ 71/s]*
- *Polymer Concentration [ppm]*

Legend:
- Red: Softened Fresh Water
- Blue: Fresh Water
- Black: Polymer Concentration
Pilot Operation

- Water viscosity
  Target: 20-25 cP

Polymer supply issues
Softening plant start up
Polymer degradation
(\(H_2S\) in blanketing gas)
Pilot Operation

- Water viscosity
  Target: 20-25 cP

Polymer supply issues
Softening plant start up
Polymer degradation (H₂S in blanketing gas)
Alternative polymer test
Pilot Operation

Polymer Injection Rate

- Total Polymer Injection Rate (6 Wells)
- Average Well Injection Pressure
Pilot Operation

- Total Polymer Injection Rate (6 Wells)
- Polymer Injection Rate (Design)
- Max Plant Injection Pressure

Injection Rate [bb/d]
Pressure [psi]

Jan-12, Jul-12, Jan-13, Jul-13, Jan-14, Jul-14, Jan-15, Jul-15, Jan-16, Jul-16, Jan-17
Pilot Operation

- Total Polymer Injection Rate (6 Wells)
- Polymer Injection Rate (Design)
- Max Plant Injection Pressure

-30%
Pilot Operation

- Total Polymer Injection Rate (6 Wells)
- Polymer Injection Rate (Design)
- Max Plant Injection Pressure
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Pilot Results

Pilot Production

- Oil rate (bod)
- Liquid rate (bbl/d)

- Pilot Start
- Base case (WOR/Np)
- Oil rate
- Liquid rate

Jan-06 to Jan-17
Pilot Results

Pilot Production

![Graph showing Pilot Production with oil rate (bod) and liquid rate (bbl/d) over time from Jul-09 to Jul-16. The graph highlights the pilot start, base case (WOR/Np), oil rate, and liquid rate.](image)
Pilot Results

The graph illustrates the comparison between Waterflooding and Polymer Pilot results. It shows the change in WOR (Water Oil Ratio) over the number of barrels of production (Np [MMbbl]) for both methods. The blue dots represent Waterflooding, while the red dots represent Polymer Pilot.
Pilot Results

Polymer Pilot (Red zone)

Waterflooding (Blue zone)

Wcut: 87%

Jan 2012 (Wcut: 82%)

Wcut: 92%

Jan 2012 (Wcut: 72%)
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Summary

Pilot Operation:
- Viscosity target has been achieved from the beginning
- Injection rate target could be reached through the increase of the injection pressure
- Production treatment did not present any problem
Summary

Pilot Operation:
- Viscosity target has been achieved from the beginning
- Injection rate target could be reached through the increase of the injection pressure
- Production treatment did not present any problem

Pilot Results:
- Positive production results have been proved
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Next Steps

- Polymer pilot will continue until the project has been fully evaluated
  - An expansion project is currently under consideration
    (Increasing the injection rate up to 44000 bbl/d)
Next Steps

- Polymer pilot will continue until the project has been fully evaluated
  - An expansion project is currently under consideration
    - Increasing the injection rate up to 44000 bbl/d
- ASP injection is being studied to further increase recovery factor
  - ASP pilot would be evaluated after polymer injection