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Introduction

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From Screening to Pilot

WHY POLYMER FLOODING

- Why Polymer Flooding
  - Relative lower degree of complexity (operational)
  - Incremental RF → positive economics
  - Low salinity water
  - High mobility ratio

- Why NOT ISC (In Situ Combustion)
  - High degree of complexity (operational)
  - HSE risks
  - Gently dipping reservoir
  - Shallow reservoir

EOR/IOR Screening Alberta Research Council (ARC) 2004
- In Situ Combustion (ISC)
- Horizontal wells
- Waterflood

Fact Finding missions 2008
1. Bakers Field, CA - ISC
2. ONGC, India - ISC - Polymer Flooding

From Screening to Pilot

- EOR screening
- Fact finding mission
- Pilot prep
  - Detail Eng.
  - Constr.
- Pilot implementation
  - Injector 1: 2008
  - Injector 2: 2010
  - Injector 3: 2011
- Pilot monitoring
- Pilot evaluation
- Reservoir Studies


Proposal comm. scale
Introduction

Pilot Area:
- 3 injectors (inverted 5-spot)

Overview of Reservoir Studies

- Preliminary Lab Studies
  - Flow-through experiments (sandpacks → Ottawa sands)
  - Coring and core analysis, including reservoir condition coreflooding experiments (with polymer)
- Reservoir Characterization Studies
  - Static model of pilot area
- Reservoir Simulation
  - Optimization of polymer injection initial flooding pattern (3 injectors & 10 off-set producers)
  - Optimal development scenarios Phase I Expansion → 6 additional injectors & 32 producers
- Polymer Stability and Retention
- Alternative Polymers
Pilot Implementation – Main Challenges & Learnings

- Realized incremental oil recovery as of July 2014 is 3% OOIP of pilot area.
- Good injectivity (SPE 154567).
- Injection viscosity (40 cP → 85 cP → 125 cP).
- Good pressure response.
- Minimal polymer degradation (SPE 164121).
- Polymer retention low (SPE 169027).
- Polymer plant downtime < 3%.

NEW ANAEROBIC SAMPLING METHOD (SPE164121)

1. Polymer stability tests pointed out severe degradation (18 to 3 million daltons).
2. Visual inspections at wellheads showed viscous fluid.
3. Several samples analyzed at different time steps → introduction of more oxygen (with iron content in polymer solution) caused higher degradation in time.
4. Improved on-site sampling
Pilot Implementation – Main Challenges & Learnings

- Total injection about 45% of the pilot pore volume (PV):
  - 24% of pilot pattern flooded.
  - 21% moved outside pilot area.
- First oil bank response already observed.
- Recent indications of pending oil cut response in a few wells probably due to injection of higher polymer viscosity.
- Some producers with possible positive skin.

Production response vs PV injected – 1M101
Realized incremental oil production

![Graph showing oil production with polymer flood pilot area](image)

Expansion Plans

- Commercial Expansion
- 27 Additional Injectors Planned
A Look Into the Crystal Ball - Expectations

- Optimal development plan for polymer flooding expansion area –
  - Optimal well locations
  - Optimal polymer injection strategies
  - Cost effective polymer

### Oil Rate Production in Area-3 by 125 cP

#### Possible upside commercial expansion: three-fold oil production rate

**Staatsolie**