IOR/EOR Practices for Enhanced Efficiency in the Evolving Carbon-Conscious Environment

11–12 JUNE 2024 | JAKARTA, INDONESIA

Unlocking Optimal Recovery in The Complexities of Challenging Geological Reservoirs :

Achieving Success Through Polymer Pilot Injection

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PTTEP

Outline

Introduction
- Field background
- Geological complexity

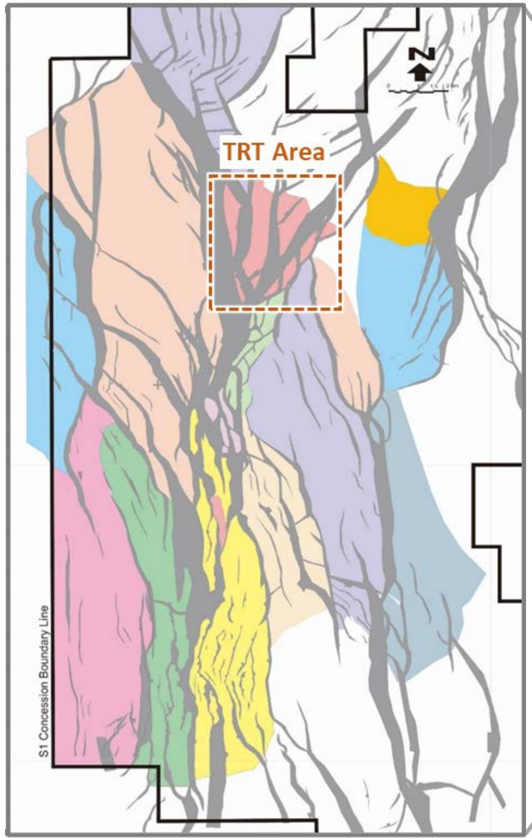
Project Preparation
- Data Acquisition Program
- Integrated Information

Polymer injection Evaluation
- At injectors
- At producers

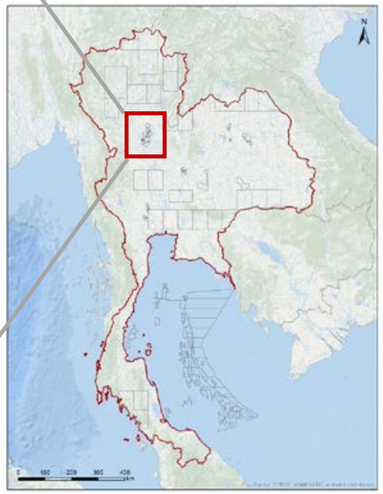
Gain Estimation
- Gain Estimation
- Economic analysis

Conclusion

Background and Geological Complexity



Thap Raet (TRT) area
located in **S1 concession**
(Onshore Thailand)

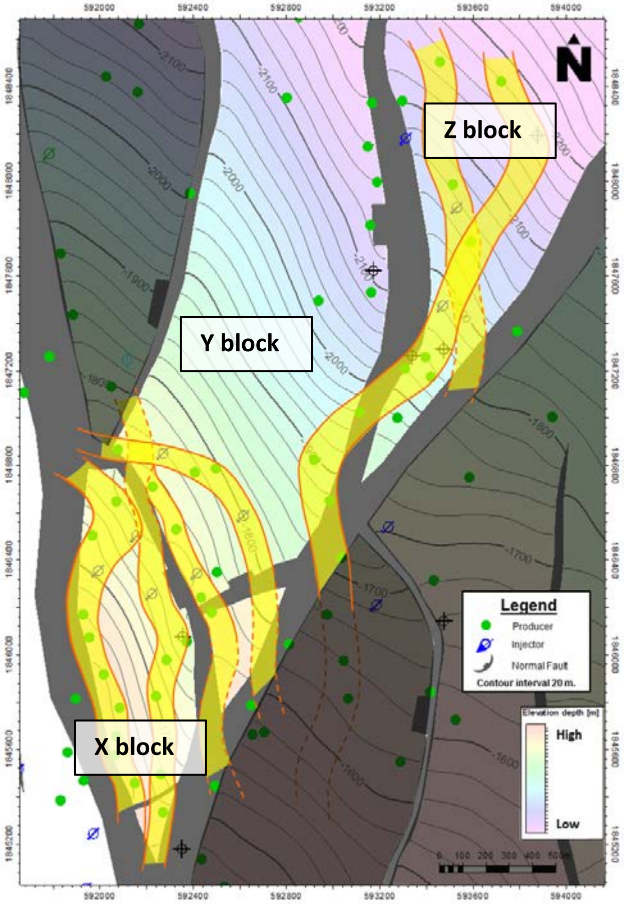


1989	2001	2017	2022
Start production	Waterflood Implementation	Pilot polymer injection	Polymer injection Implementation

Geological Characteristic

- Multilayer sandstone reservoir
- Challenged structures & wells trajectory
- Meandering fluvial sediments
- Random channels distribution & thin reservoirs
- Multiple fluid regimes

Interpreted Channel



Reservoir properties

Reservoir thickness (m)	2 - 30
Reservoir temperature (°C)	85
Average porosity	0.15 - 0.20
Average permeability (mD)	50 - 100
Oil density (°API)	39
Oil viscosity (cP)	1.4

Project preparation

Reservoir Simulation

Various scenarios

- Optimal polymer concentration
- Target viscosity
- Slug size
- Incremental recovery factor **(RF)** 0.5% - 3.3%.

Laboratory Polymer Screening

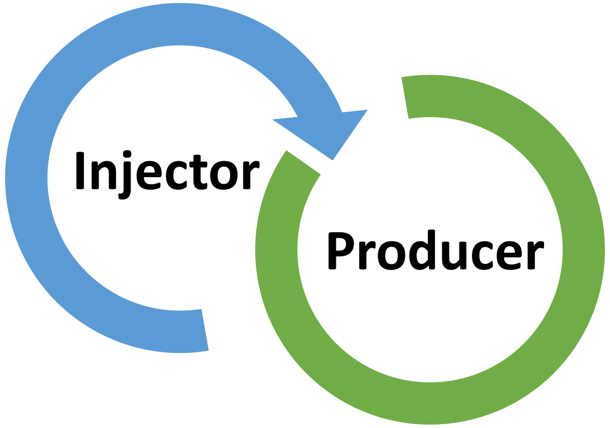
The screening program : pass all 4 tests

- Compatibility test
- Viscosity measurement
- Filtration test
- Thermal stability test

Data Acquisition Program

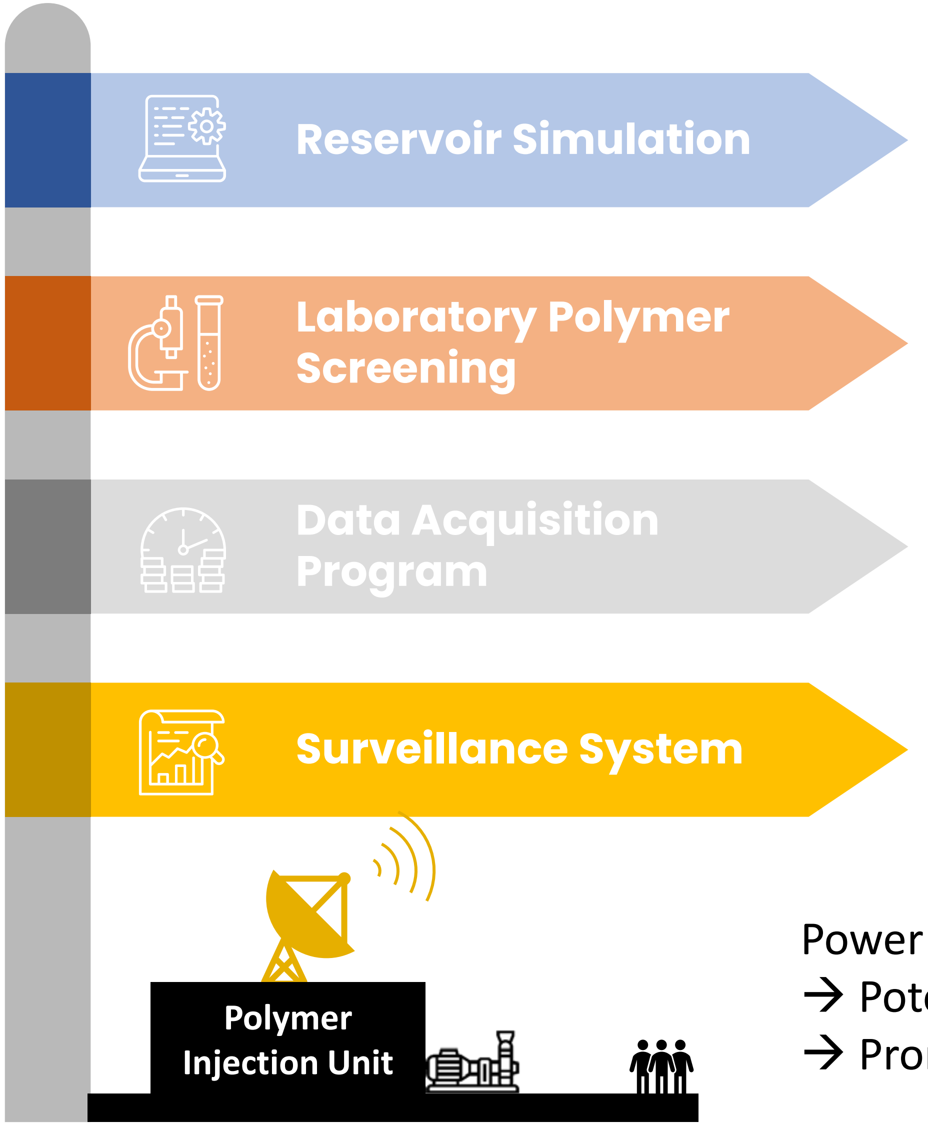
Scheduled both prior to and during the injection period to capture polymer flood response

- Rate & Pressure
- Injection log
- Fall-off test



- Well test
- Wellhead sample (WCUT, Polymer concentration)
- Pressure

Project preparation

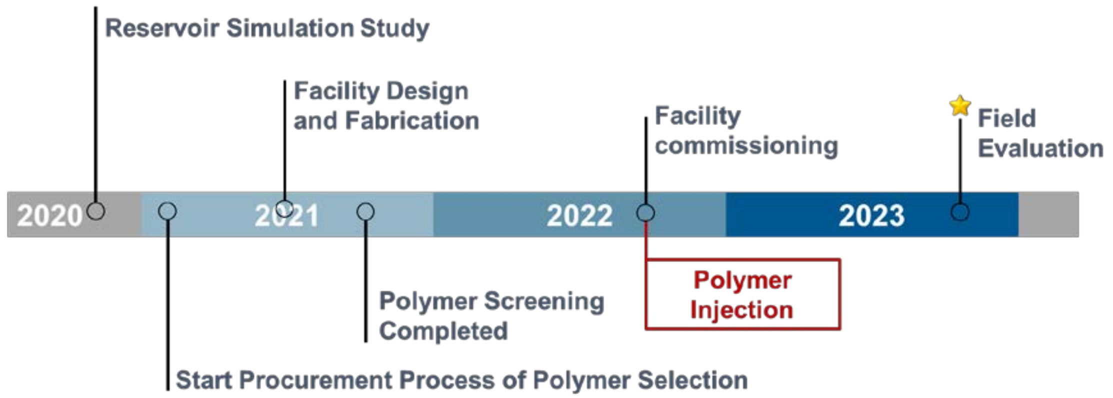


Power BI dashboard displayed integrated information.

→ Potential issues can be identified early

→ Prompt mitigation actions for a smooth and uninterrupted injection process.

Large-scale Polymer Injection

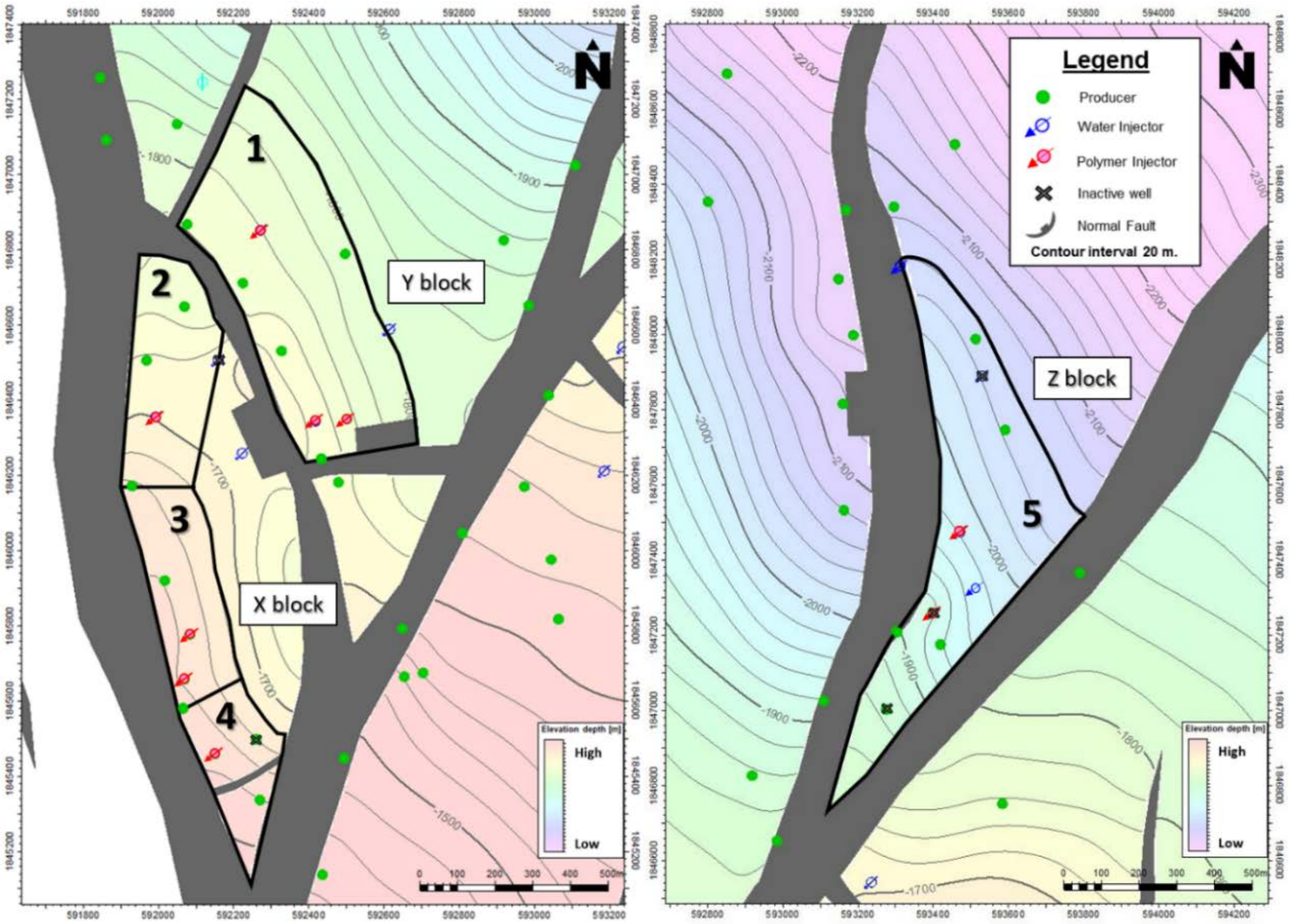


Injection strategy

- Continuous injection
- 3 Blocks with 5 Patterns
- 8 Injectors & 15 Producers

Facility

- 1 pump per injector well
- Polymer injection rate 200 –1000 BPD/well
- Total unit injection rate 3000 – 5000 BPD

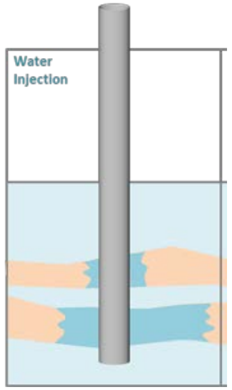


Evaluation

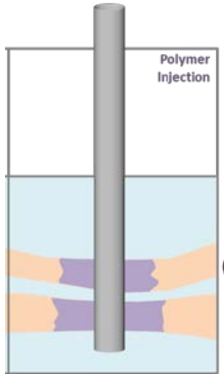
Location	Success Criteria	Rationale
At Injector	Flow conformance improvement ✓ Observed injected water diversion from high permeability streaks to lower permeability units	Measurement of polymer effectiveness in diverting the water to lower permeability sands.

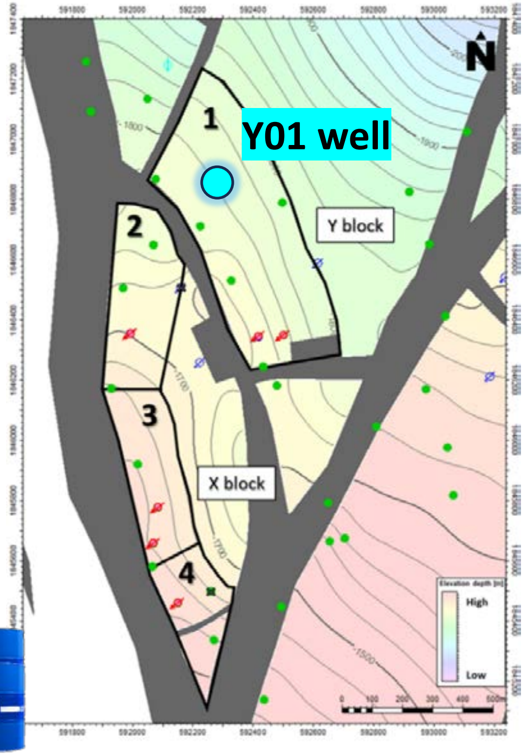
Injection Logging Tool (ILT) Results

	21-Aug-22	09-Jan-23	31-May-23
	Water	Polymer	Polymer
ZONE_NO	%	%	%
I	0.0	0.0	0.0
I	0.0	0.0	0.0
I	0.0	0.0	11.6
I	52.9	35.2	27.6
I	15.0	11.3	10.2
I	4.5	8.5	7.4
I	9.5	18.2	17.3
I	8.3	12.4	12.4
I	9.8	14.4	13.5
Total	100.0	100.0	100.0



Improve
vertical sweep efficiency



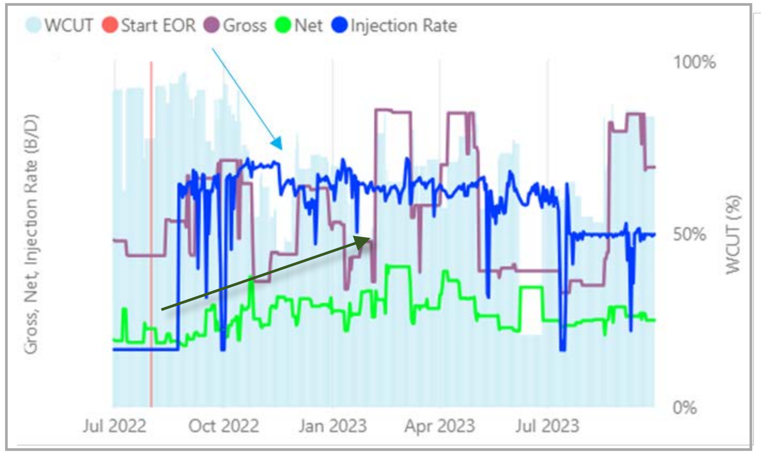


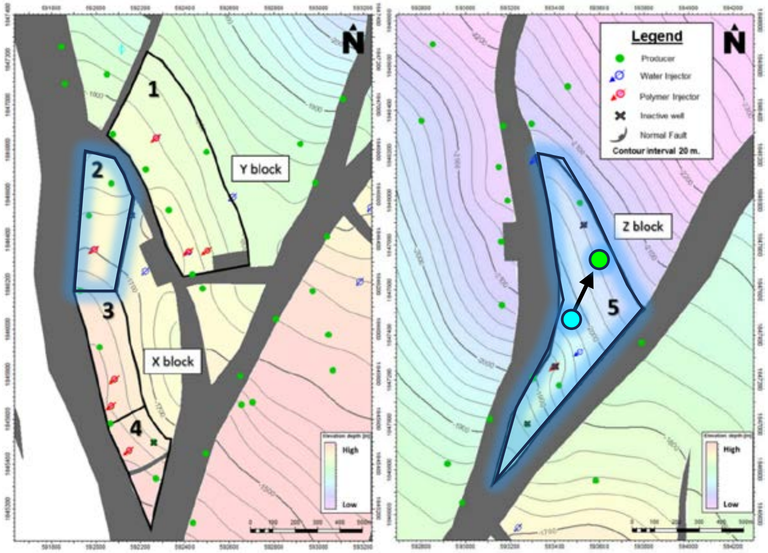
Evaluation

Location	Success Criteria	Rationale
At Producer	✓ Increased oil cut ✓ Reduced water-cut	Measure of the outcome of the pilot, that is to increase the oil production through improved flow conformance of water injection using polymer.

X block: Pattern 2

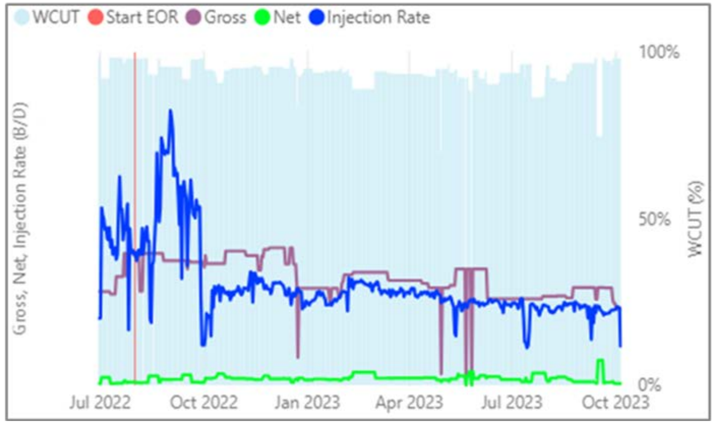
- 30% WCUT reduction after 5 months





Z block: Pattern 5

- WCUT reduction observed in only 1 producer
- No significant oil gain from other producers



Lower waterflood maturity → Better response from polymer injection

Block	Cumulative VRR	WCUT
X	0.59	75%
Y	2.29	98%
Z	1.37	95%

Operational Challenges

Producer issues

- Tubing leak in many producers leading to workover operation

VRR control

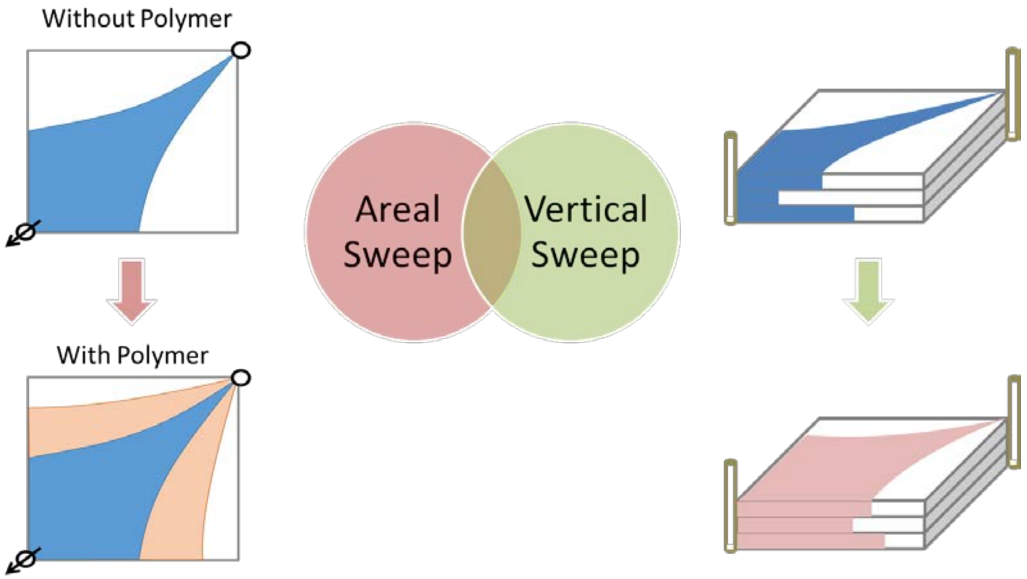
- Unexpected closed-in producers cause gross production change
- Operational constrain cause VRR control difficulty

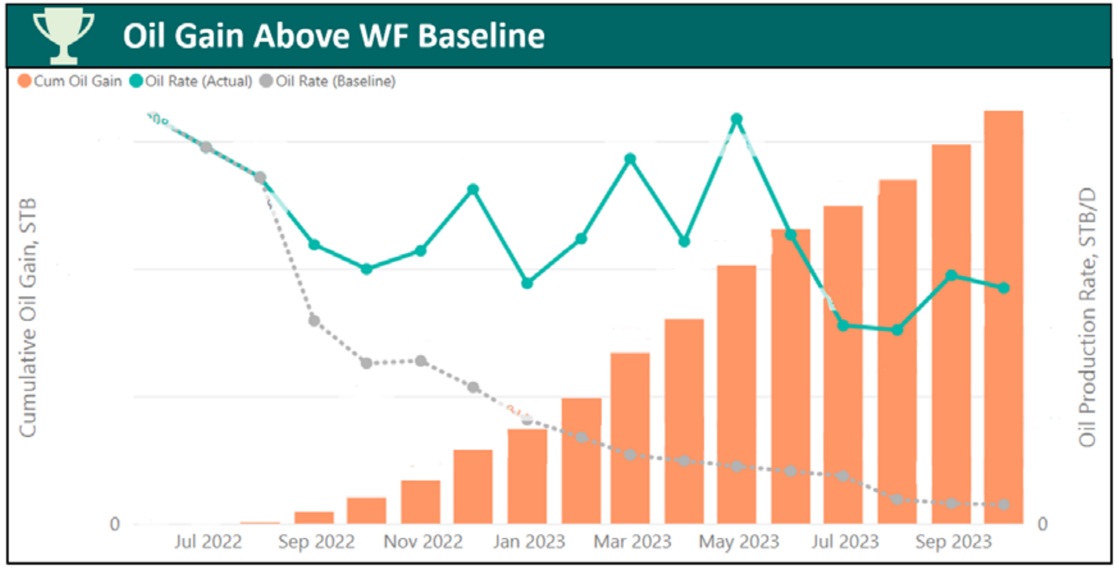
Injectivity concern

- Injectivity deteriorates with time
- Unable to inject in an injector since the beginning

Society of Petroleum Engineers

Gain Estimation & Economic Evaluation





Estimate oil gain by **analytical tool**
- Log wCUT vs Np Plot
- DCA

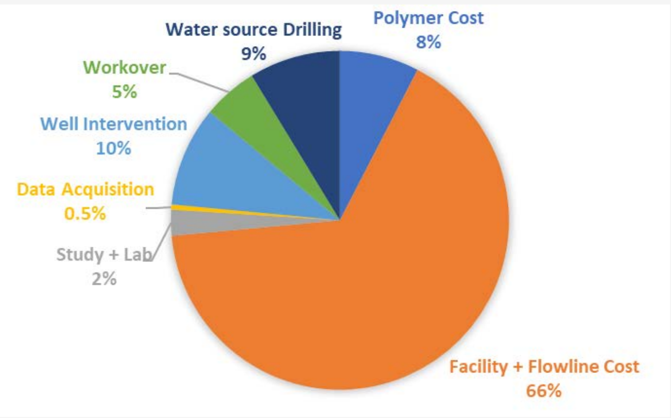
Up to

3%

Recovery gain over waterflooding
Vary by block from 0.6 – 3.0%

Positive NPV result

- Breakdown cost



Conclusion

Preparation Phase

- Reservoir Simulation
- Laboratory Polymer Screening
- Data acquisition Program

Pilot project & Monitoring Performance

- Surveillance System
- Displayed Dashboard

Operational challenges

- Lesson Learnt
- Further Project Improvement

Evaluate Results

- EOR Gain Estimation
- Economic Analysis

Approach to other areas with similar reservoir characteristics as a **full-field development**