Enhancing Waterflooding Performance
On the Path to Autonomous Operations

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Agenda

Field Context

Challenges

Proposed Solution

Way Forward
Overview

Summary
- Several fields scattered over ~800 Km2 (NS)
- Reservoir management currently migrating from primary to secondary recovery

Subsurface:
- Depleted reservoirs with limited active aquifer

Facilities:
- Scattered in small clusters
- Power reliability one of main concerns
Business Challenges

• Time to decision to meet production targets
• Inefficient optimization system.
• Generate actionable insights on waterflood management
Technical Challenges

- Primary recovery mindset and lack of previous experience in waterflooding
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Technical Challenges

- Primary recovery mindset. No previous experience operating assets under water injection recovery
- Combination of deviated injector wells and deviated/horizontal producer wells
- Steep decline with early water breakthrough
- Fluid handling restrictions (fluid transfer process to processing station).
The Solution: AI driven waterflood optimization

Customized decision support system for operational pattern flood optimization
- Physics based models
- AI driven workflows
The Solution Development Approach – Design Thinking & Agile

**EXPERIMENTAL PROTOTYPE**

Prove and demonstrate that it can be done!

**DEPLOYABLE PROTOTYPE**

Validate and use in selected pilot project(s).

Intense collaboration, quick prototyping and field trial, Refine and mature for operational use
Waterflood Optimization Framework
Solution Overview

Models & Pattern Analysis
- Observed data
- Modelling (Physics, AI/ML)
- Pattern analysis

Decision Analysis & Management
- Pattern balancing
- What-if scenarios
- General insights
- Short term and mid-term forecasts

Actions
- Recommended production and injection
- Remedial operations
- Field implementation
- Monitoring & Surveillance
ML Assisted Physics Model

**STEP CHANGE IN PERFORMANCE**

- Field pilot test reduced time to rebalance patterns from 23 hrs ➔ 5 hrs
Proven Pattern Balancing Algorithm (PFM)

**Robustness Pattern Balance Algorithm and Forecasting Capability**

- Smart algorithm for allocation factors

**What-If Capability**

- What-If using operational parameters
- Unscheduled events
Waterflood Operations Surveillance Dashboards

Preserve integrated reservoir management with optimum pattern balance
Value Delivered

**Time to decision**
- Improved analysis efficiency by 80%
- Optimization time for 40 wells from 23 to 5 hrs

**Operational optimization**
- Proactive response to operational upsets (What if with iPFM)
- Reducing field visits & HSE exposure

**Actionable insights**
- Reliable 90 days forecast with uncertainty
- Better understanding of injection-production relationship
Towards Autonomous Waterflood Operations

Driving to Location Reduction (10 to 3 visits)

CO₂ Emissions Reduction

Reduce Energy Consumption (~ 150 kW)

Increase Operational Decisions

70 %

0.6 Ton/month

17%

30%

Digital Architecture

Recommended operational settings

Data input flow

Visualisation

Agora

Communication

Satellite (Agora)

Fiber Optic

Control & Automation

sensia

Edge Computing

Agora

Smart Physical Assets

Excellence in Execution
Conclusions

- Waterflood Optimization Framework that can support future Autonomous Digital Operations

- Injection pattern analysis and optimization tool for operational decision situations

- Design thinking approach: very effective to move from innovative idea into practical solution.