Well Portfolio Optimization (WPO) deployment in CaspiNeft Kazakhstan

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Content

1. About CaspiNeft
2. Project Motivation and Objectives
3. Problem Definition and Analysis
4. Problem Solution
5. Deliverables
6. Benefits Analysis (Benefits to Schlumberger and/or Clients)
7. Conclusion
About company and field

- One of the biggest Independents in West Kazakhstan
- Operates Airankol oilfield, located in Caspian region
- Digital Oil Field (DOF) implemented from 2020
- WPO deployed as part of DOF
- Has its own geological, production department and several workover teams with rigs

- Discovered in 1979
- Atyrau region, Kazakhstan
- 2 domes (East and West)
- 200 vertical wells
- Depth of reservoirs:
  - 610 - 910 m in Cretaceous
  - 1050 - 1500 m in Jurassic
- Production with ESP, PCP, SRP
Project Motivation

Drivers
- Company has an ambition to grow as major independent regional player
- Transformation through digitalization and deployment of DOF

Strategic objectives
- Increase business and operational efficiency
- Reduce costs and maximize recovery
- Increase investment attractiveness of the asset in long term
Asset Problems and Challenges

CHALLENGES

TIME & RESOURCES
- High-well count assets (200 wells)
- Manual and tedious screening of intervention opportunities

DATA ANALYSIS
- Different sources and type of data
- Too many factors and criteria for manual analysis
- Difficult to analyze existing data

RESERVOIR
- Complicated reservoir with multizone structure
- Required proper water and pressure management

WORKOVER PROGRAM
- Active workover campaign
- Growing number of problem wells and workovers
- Two workover teams full utilized

PROBLEMS
- Decision quality suffers because not enough time & resources
- Unplanned stops are not analyzed systematically
- No quantitatively analysis of lost production due to stops
- Ineffective utilization of workover rigs and personal
Well Problems

- Completion Inefficiency
  - Re-perf Stimulation
- Pressure Depletion
  - Water Shut Off
- Water Problem
  - Zone Change
- Artificial Lift
  - Well cleanup
- Wellbore
  - Convert to Artificial Lift
  - Upgrade Artificial Lift
- Resize Pump
  - Install VSD
  - Optimize Pump

Different actions would impact well rate differently – some may reduce:

- insufficient Pressure
- low Remaining Reserves
- water breakthrough
- formation Damage
- low Perforation
- low Permeability
- paraffin/wax formation
- insufficient Pressure Lift
- lift Upgrade
- lift Optimization

RESERVOIR

- insufficient Pressure

WELLBORE

ARTIFICIAL LIFT

COMPLETION
Proposed solution: Well Portfolio Optimization (WPO)

Opportunities
- Increase Drawdown/ Upgrade Pump candidates
- Add Perforation candidates
- Reperforation/ Stimulation candidates
- Frac Stimulation Candidates
- Zone Change candidates
- Water Shut Off candidates
- Decrease Production candidates

Analytics components
- BHP & PI Modeling
- Automated production forecasting
- Chan analytics
- Analytic Hierarchy Process

Automation
- Customized the solution

Business Logic
- Customized the solution

Advisory System
Solution design

Production Enhancement Wells

Performance
- Heterogeneity Analysis
- Type Well Analysis
- Areal Trends: WC/WGR

Potential
- Reserves
- Incremental Production
- Pressure
- Reservoir Quality Index

Root Cause Analysis

- Water Production Diagnostics
- Formation Damage Index
- Multi-dimensional HI Plots
- Artificial Lift Performance Trend Analysis
- Pressure Trend Analysis
- Recoverable Reserves
- Liquid production per perf pay
- Behind Casing Potentials
- Vertical Flow Barrier Analysis
- Distance to WOC

Interventions

- Zone Change
- Water Control
- Well Cleanups
- Stimulation
- Re-perforation
- Addition of Perforation
- Pump Upgrade
- Pump Optimization

Quantify Gains

- Offset Well Performance
- Well PI Analysis
- Behind Casing Potentials

Prioritize

- AHP based ranking
- Gain based rankings
- Economics based Ranking
Screening | Water Control | Water Shut Off

- Oil – Water HI
  - LOHW HOHW
    - WC | E > xx%
    - WC | W > yy%
      - Good
        - Zone Change Workflow
          - RR / EUR < zz%
            - No
              - Chan Analytics
            - Yes
              - Exceeding Water Management Limit?
                - No
                  - Continue to Produce
                - Yes
                  - Run PLT
                    - Areal WC Trend Top 5
                      - No
                        - Channeling
                      - Yes
                        - Reduce Choke
                          - Opportunity
                            - Calculate Opportunity Potential
                              - Calculate Opportunity Potential
                                - WSO
Diagnose | Analytics engines

- Automatic DCA Forecasting
- Heterogeneity Index
- Type Well Comparison
- Areal Trend Analysis
- Behind Casing Opportunity Model (+ML)
- Chan Plot Analysis

BCO PI Predictions
Analytics engines | BCO analysis with ML

ML ENVIRONMENT

Feed Learner
Various Data

Align Type of
Learning System

Result
Presentation

Clustering Algorithm

Random Decision Forest

predicted Qoi

Actual
predicted

Prodzone

Kh, neighbor Di

porosity

neighbor Qoi

Instance

f(x)

Learning Algorithm

predicted Qoi

Actual
predicted

Prodzone

K1

LTC

Analytics engines | BCO analysis with ML

f(x)

Clustering Algorithm

Random Decision Forest
Analytic Hierarchy Process (AHP) is used to analyze a multi-criteria decision analysis (MCDA) problem

- Reduce complex decisions to a series of pairwise comparison
- Synthesize both quantitative and qualitative criteria in objective manner
- Provide the capability of consistency checking
- Structure engineering decision making process into hierarchical decision trees
WPO | Final candidates ranking

Respect to the budget

Exceed the budget

positive NPV  negative NPV
positive NPV  negative NPV
Workover implementation | Well 116

Screening

Recommendation: Horizon change

Field implementation

Status before WO:
- Rate: 1 m³/d
- Water cut 97.5%
- Flowing horizons: Apt, Ne-I
- BHP 67 bar (forecast)
- Pressure drawdown 14 bar

Calculations before WO:
- $H_{\text{perf}} / H_{\text{sand}} = 0.8$
- Well PI: 0.04 m³/d/bar
- Oil cumulative: 10 736 m³
- Remaining oil: 472 m³

Chan plot:
- Water breakthrough probability: 99%
- Remaining oil: 4.2%

Proposed horizons to change:
- Alb: oil rate increment - 13 m³/d
- Ne-V-A: oil rate increment - 6 m³/d

WPO conclusion:

- WCT reduced 98% → 15%
- Oil rate increased 1 m³/day → 37 m³/day
Workover implementation | Well P-15, 237, ОЦ-21

Well P-15
Field implementation:
• WCT reduced: 96% => 25%
• Oil rate increased: 1 => 40 m3/day

Well 237
Field implementation:
• WCT reduced: 98% => 15%
• Oil rate increased: 1 => 37 m3/day

Well ОЦ-21
Field implementation:
• WCT reduced: 96% => 70%
• Oil rate increased: 1 => 20 m3/day
Benefits & Deliverables

- Daily basis automatic screening
- Automatic problem well and cause of low productivity identification
- Quantitative analysis of best suitable type of workovers
- Ranking of most “desirable” candidates
- Standardized approach of candidate screening and workover type analysis
- Ongoing knowledge base update after implementation
- Automatic web reports

Recommendations after analysis
> 150 wells of Airankol Field

- Increase drawdown 57%
- Re-Perf 18%
- Zone change 4%
- Reduce prod 9%
- Run Pit/WSO 6%
- Add perf 4%
- Frac stim 2%

Manual Process

Well Review Frequency

Gain = 1270 m3/d
* Potential profit from incremental production
from 1 week to 30 mins

Accuracy

Profit
Thank you