An Integrated Technological Approach Towards Further Field Development and Production Enhancement

Case Study: Robertkiri Integrated FDP
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Agenda

• Introduction
• Field Overview
• Challenges/Problem Statement/Objective
• Methodology/Integration
• Results/Field Development
• Belemaoil is in Joint Venture partnership with NNPC

• Acquired 40% interest in OML 55 in 2013

• Operator of OML 55 Asset

• Currently, the daily cumulative production is circa 10,000 bopd and most of the produced associated gas is flared with a small amount being used as fuel gas to meet the facilities instrument and power demand.

• Belemaoil intends to add to the depleting reserves

• To further develop the Oil and Gas resources in OML 55; increase gas supply into domestic market; implement Gas Flaredown Policy in OML 55
Field Overview

Robertkiri Field:

- Situated within the Coastal Swamp Depobelt of Niger Delta, Nigeria.
- Discovered in 1964 and production started in 1979
- HC accumulation is on the downthrown part of the Robertkiri fault
- Primary reservoirs are Miocene in age and middle to lower shoreface sand with some tidal channels
- About 20 wells drilled (9 active, 6 shut-in and 5 plug and abandoned), 28 Oil and Gas bearing reservoirs
- Reservoir Depth 8,000 -16,000fts
- Porosity ranging between 18 -30%, Permeability of 500mD-2500mD and Water Saturation between 15-40%
- Robertkiri Production Facilities - Design Capacity of 22,540 BOPD, 10,000 BWPD and 36 MMSCFD Gas
Objective

To use the State-Art-Technology to carry-out an Integrated Field Development Study to further develop the Robertkiri field potential.

• Evaluate Hydrocarbon reservoirs by analyzing static & dynamic uncertainties in Robertkiri Field Development Project.

• Select Fit-for-Purpose Models which would incorporate the range of uncertainty in key variables for use in concept selection and development planning scenarios.

• Assess and optimize various development scenarios and select optimum development wells on an individual reservoir level.

• Allocate areas of by-passed oil that can be a target for drilling.

• Propose a Field Development Plan that can improve production and maximize reserves.

• To deliver about 120mmscfd of gas into the domestic market.
Objectives of the Subsurface Data Acquisition

- Validate the identified oil and gas development opportunities for well intervention in OML-55.
- It is also for well reservoir management (WRM) and to satisfy other statutory requirements.
- Acquired data will be used to update static and dynamic reservoir models and to support ongoing subsurface studies.
- Data to be acquired includes, but is not limited to:
  - CO logs using Reservoir Saturation Tool (RST) to identify current fluid contacts
  - Static Bottom Hole Pressure (SBHP) survey for all OML55 sands
  - Cement Bond Log with Variable Density Display (CBL - VDL)
**OML-55 Value Chain**

**Exploration**
- OML-55, areal size of about 852 sqkm, spatially covered by seismic data.
- Only about 40% covered by seismic data.
- The quality of the current seismic data deteriorates with depth, below 3000 msec.
- Area characterized by Fault shadow Imaging problem.
- OML-55 reserves rapidly depleting as its ageing.
- **15 Prospects and Leads** to be matured.

**Appraisal**

**Jokka field**, a field with one (1) exploration which was converted to a producing well to develop the field.
- Actual value of Jokka field yet unknown.
- Aggressive appraisal activities currently ongoing to ascertain the extent of the pool.
- Planned appraisal well to target the deep opportunities in this field.

**Inda** and **Idama Fields**.
Planned ongoing to appraise the deep opportunities in the two(2) fields by drilling deep appraisal wells.

**Development**
- Aggressively close out all outstanding OML-55 subsurface data acquisition:
  - **Validate the identified oil and gas development opportunities for well intervention.**
  - **Also for well reservoir management (WRM) and to satisfy other statutory requirements.**
- Development drilling post subsurface data acquisition interpretation.
- Progress with planned OML-55 field wide water shut-off campaign activities.
- Close out the Robertkiri Gaslift project.
- Gas cap blowdown and NAG development with associate condensate.
- Produced water handling

**Gas Development**

**Robertkiri Gas Development Project:**
- To unlock the Associated (AG) & Non-Associated Gas (NAG) potential in this gas field. The greatest potential of Robertkiri field is inherent in the gas field development.
- 120 MMSCFD of gas to be delivered into the domestic market 2021.

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**ACQUISITION**
- Terrain – Swamp and Shallow water.
- SOW – circa 1300 sq km
- Fold Multiplicity = 180

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Integrated Workflow Utilizing Schlumberger Cutting Edge Technology
Integrated Technology enabled robust G&G workflows that accurately links structural complexity of this field, depo-facies and updated in-place volumes to improved field-wide Dynamic Behavior and Production Optimization.
Production Optimization

Well Model Creation
- Completion
- Production Test History
- Static Pressure History
- Well Head Pressure

Well Model Calibration
- Flow Correlation Data Matching
- Hold up and friction factor tuning
- Nodal Analysis
- Gas Lift Optimization
- Tubing size selection
- Decline Curve Analysis

Well Screening/VFP Table
- Workover Candidate Well selection
- VFP Table Creation

The well performance study has been beneficial in determining the impact of various options to increase production so that an economic assessment can be made for various workover options.
6 Reservoirs have active wells producing from them. The low producers would be considered for optimization or as candidate for water injection or disposal

- B-08, C-01, C-03, C-08 E-12 and E-1B

*All analysis will be in conjunction with reservoir simulation work*
Candidate Screening for Water Injection

* denotes potential wells that may be re-entered to produce remaining reserves and then converted to water injection/disposal wells.

- 14 candidate strings for WI/D
- 18 candidates for WO
  - 6 drainage points for re-entry
  - 4 drainage points for GL optimization
  - 4 drainage points (2wells) replace wellhead
  - 4 drainage points require AL installation

Potential wells for intervention/NFA

Potential wells for water injection/disposal
Reservoir Engineering

Model Initialization

- PVT Models / BO Tables
- Kr and Pc Curves
- Aquifer Model
- Observed Data / Well Events

History Matching

- HM Objectives Based on Business Decision
- Objective Function and HM Criteria

- Select Variables and Uncertainty Ranges
- Select HM “Method” 1) Experimental Design 2) Optimization
- Measure Match Quality Based on HM Criteria

- Initialize Model

Production Forecasting

- VFP Tables
- Network Model – THP Limits
- Development Scenarios / Options

- Prepare and Run Scenarios
- Sensitivity on Development Options
- Uncertainty Analysis on Develop. Scenarios

- History Matched Model

Integrated Asset Model

- Integrated Model
- Create integrated model with base reservoir case and network model

- Adjust Network
  - Flowline Size
  - Turbulence
  - AI. methods

- Time Based Network Results Analysis
  - Runs
  - Pressures
  - Temperature
  - Fractal velocities
  - Power consumption
  - Gas compression

- Integrated U&D Model
- Run different U&D cases coupled to network model

- Analyze the Asset and Make Decision

Schlumberger
Facilities Concept Design – Way Forward

• Review available data from field and neighboring assets
• Review reservoir modeling output
• Review and agree an initial basis of design
• Setup FDP layout in Accelerated Conceptual Engineering (ACE)
• Build required surface production systems model
• Review process inputs, run cases and amend the input
• Review and finalize equipment for new facilities
  ◦ Extract Long Lead Items list
  • Build CAPEX and Abandonment cost model.
  • Develop high level OPEX model for each concept
  • Benchmark costs

• Description of Facilities Concept plus rationale for concept selection
• Development schematic, PFDs & H&MB
• Preliminary equipment sizing
• Equipment and utility load estimates
• Capex estimates and estimating basis
• High level OPEX estimate
• CAPEX estimation for new facilities. AACE Class 3/4
Economics - way forward

Expected economic analysis to ascertain the commercial implication of all technical input and data required to guide critical business decisions and implementation of the Field Development Plan such as:

- Cashflow Analysis
- Fiscal Analysis (Contractor Vs Government Take)
- Economic Indicators
- Uncertainty Analysis
Conclusion

Integrated workflow is expected to achieve the following:

• Production Enhancement
• Reservoir Management
• Multidisciplinary Integration
• Results/Field Development
• Authors would like to thank Belemaoil Producing Limited and Schlumberger for their permission to share these workflows and Best practices.