Successful Implementation of an Integrated Production Network Model for the Heera Field

Pavan Aggarwal, ONGC Ltd
Manickam Nadar, EPS Ltd.

Presenter:
Pavan Aggarwal, ONGCL

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Tangible Results

- Successful construction and calibration of a large scale, complex production network model which is robust and reliable
- First full field integrated production model operational in India
- Implementation of recommendations (ongoing) has so far resulted in an increased production of 1700 BOPD (4%)
- Model and workflows are being integrated into ongoing gas lift surveillance and field optimization procedures
Outline

- Introduction
- Objectives
- Model Construction, Calibration & Analysis
- Optimization Recommendations
  - Well Models: GL Design improvements
  - Network Model: Field Gas Lift reallocation
- Implementation Strategy
- Results achieved so far
- Conclusions & Lessons Learned
Introduction

Heera Field, offshore Mumbai, India.
- OOIP – 285 MMT.
- Mature Producing Field
- 119 GL Producers + 59 Injectors
- Current Production ~45,000 stbo/Day
- Formation GOR 120 m³/m³
- Average WC ~55%
Objectives

Present a case history describing successful implementation of optimization methodology in a major gas lifted field.

Outline the structure and methodology for constructing and calibrating a large integrated production model.

Provide an optimization solution which takes account of network and other constraints.

Illustrate the potential applications in running the completed model in optimization mode.
Well Modeling
Nodal Analysis

- Well model construction:
  - Reservoir, production string & artificial lift system
- Calibration with FGS/production test data (at date of FGS)
- Update model to current well production test data
- Calibration of lift gas injection parameters
- Use updated model to perform gas lift diagnostics and identify uplift potential
- Gas Lift well performance surfaces generated for the network model
- 119 wells on 15 well platforms
Well Gas lift designs were modified / optimized to achieve the following:

- Ensure single point lift
- Improve gas lift depth using the available injection pressure
- Update gas lift design for changed inflow conditions
- Use of orifice valves at operating mandrel station
Well Modeling Results

- **Gas Lift Redesign / Optimization potential:**
  - 22 Candidates identified with more than 50 BOPD uplift.
  - 5 candidates require only gas lift rate optimization.
  - 17 candidates for gas lift redesign.
  - Of these, 12 candidates with potential gain of more than 100 BOPD (high priority).

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**Gain Estimated vs. Gain Achieved**

- **Oil Gain (BOPD):**
  - HC-5, HSA-2, HD-10, HC-3, HB-12, HF-10, HSB-2, HT-10, HC-2, HSA-1, HSB-1, HSB-5.

- **Legend:**
  - Green: Gain Estimated
  - Blue: Gain Achieved

- **Note:**
  - No WO Job Carried out
Network Modeling

- PVT: Black Oil; 4 different fluid PVT datasets.
- Wells: well head performance curves
- Pipe/Flow Lines: 452 pipe elements
  - Production & gas injection lines on facilities and well satellite platforms (including risers, flow lines, elevations, sea/air environment, pipeline insulation etc.):
- Process Equipment:
  - Multistage separators (4xHP/1xLP/1xLLP)
  - Gas lift compressors (5)
  - heat exchangers, valves, chokes, etc.
- Recycle loop (LP gas recovery)
- ICP and Neelam satellites (using Source objects)
Network Model: Construction
Network Model: Construction

Process Modeling includes:
• Flowlines, block valves
• Chokes, control valves
• Separators, Heat Exchangers
• Compressors, Pumps
• Various constraints (pressure, flow, temperature) in the network
Optimization Scenarios

- Optimization Scenarios Investigated with History matched Model:
  - Base Case – gas lift reallocation (Network Gas Lift Optimization)
  - Optimum separator pressure
  - Optimum gas lift header pressure
  - Compressor shut-in
  - Pipeline de-bottlenecking
Network Optimization Gains

![Network Optimization Gains Graph]

- **Platform**: HA, HB, HC, HD, HE, HF, HQ, HR, HS, HSA, HSB, HT, HV, HX, HY
- **Estimated Gain**
- **Achieved Gain**

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## Optimization Results

### Optimization gains (Base Case):

<table>
<thead>
<tr>
<th></th>
<th>Predicted gain</th>
<th>Achieved gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well GL designs</td>
<td>1500 bopd</td>
<td>800 bopd</td>
</tr>
<tr>
<td>Field gas lift</td>
<td>1500 bopd</td>
<td>900 bopd</td>
</tr>
<tr>
<td>reallocation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lift Gas Savings</td>
<td>8%</td>
<td>6%</td>
</tr>
</tbody>
</table>
## Pipeline De-bottlenecking

**Table:**

<table>
<thead>
<tr>
<th>HC-HA Pipeline size, in.</th>
<th>HC Oil production rate, STB/Day</th>
<th>HC Water production rate, STB/Day</th>
<th>HC Lift gas consumed, Mscm/day</th>
<th>HC Production manifold pressure, Kg/cm²g</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>4347</td>
<td>2261</td>
<td>90382.2</td>
<td>13.87</td>
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<tr>
<td>14</td>
<td>4792</td>
<td>2512</td>
<td>94784.4</td>
<td>9.08</td>
</tr>
</tbody>
</table>
Heera Re-development (New pipeline)
Implementation

- Stepwise, fieldwide
- On each well: change → stabilize → monitor then review results
  - Good – continue to the next step
  - Not good – review well model and update
- Work as a team
- Production rate changes better monitored at the facilities level (*measurable benefits*)
- Individual production well tests are critical for well model calibration and review
Conclusions

- An integrated production model of the Heera Field has been successfully constructed, history matched and used to optimize lift gas allocation for increasing oil production. This is the first model on this scale which has been successfully implemented in India.
- Optimization results predict a potential uplift of 6-8% in oil production. Early implementation in the field to date through well interventions and lift gas reallocation have so far raised oil production by 1700 BOPD (4%).
- Optimization runs with the network model help assess the cost-benefit impact of changes in separator pressure and gas lift header pressures.
- The network model can be used to investigate the benefits of up-sizing pipelines. Additional economic analysis is required to support such recommendations.
- A calibrated & updated network model can be used for optimizing the size & location of future pipelines in the field.
Lessons Learned

- Modeling and optimization of field production networks should be an integral part of artificial lift surveillance, maintenance and upgrading.
- Building or analyzing results of models often results in new ideas and gains.
  - Collaborative thinking
  - Challenging existing design criteria
- Challenges in implementing model recommendations:
  - GLV changes could be done in 2/3rd of the planned wells in Heera.
  - Well intervention jobs have inherent risks. Careful planning & management support is required.
- A Multi-discipline team (well production engineer, facilities engineer and operations personnel) was required to coordinate the jobs, and monitor and analyze the results.
Acknowledgement

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