Real Time Optimization of Gas Lifted Asset using Integrated Production Model

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Weatherford International, Houston
Outline

- Integrated Production Model
- Challenges in Optimization of Gas Lifted Asset using Integrated Model
- Adoption of Integrated Model for Real Time Optimization
- Real Time Optimization Solution
- Conclusions
Production Optimization

Single Well Optimization

• Well Modeling Software
  – Nodal Analysis
  – Gas Lift Design and Analysis

Full Field Optimization

• Integrated Production Model
  – Reservoir
  – Well
  – Surface Facilities
Well Modeling Application

Reservoir Pressure
Gas Oil Ratio (GOR)
Water-cut
IPR Data

Naturally Flowing Well

Gas Lifted Well
THP = 100 psia
THP = 200 psia
THP = 300 psia

Qoil, STB/day
Qgi, MMScf/day

Surface Network Application

Integrated Production Model
Challenges in Field Optimization

Well Performance Data

• Naturally Flowing Well
  – Single Curve => $Q_{oil}$ vs THP

• Gas Lifted Well
  – Performance Surface
    • $Q_{oil}$ vs $Q_{gi}$ for range of Tubing Head Pressures
  – Casing Head Pressure Corresponding to $Q_{gi}$
    • Advanced Gas Valve Modeling (AGVM)
  – Minimum Kick off Rate
Challenges in Field Optimization

Feb. 2 - 6, 2009

2009 Gas-Lift Workshop
Challenges in Field Optimization

Availability of Lift Gas

• Quantity
  – Separator Train Configuration
    • Number of Stages
    • Pressure and Temperature

• Pressure
  – Compressor Station Configuration
    • Number of Compressor Stages
      – Surge and Stonewall limits
    • Turbine
      – NHV of Gas
Challenges in Field Optimization
Challenges in Field Optimization

Optimizer

- **Objective**: Maximize Revenue
  - Maximize Production and Minimize Cost
    - Optimum Distribution of Available Lift Gas
    - Compressor Performance
    - Minimize Recycled Gas between Compressor Stages

- **Solver**
  - Closed Loop Optimization
  - Recycle Loops
  - *Simultaneous Simulation and Optimization*
Optimization Methodology

Tune Individual Well Models

- Production Well Test Data, Flowing Gradient Survey
  - IPR Model
  - Flow Correlation

Tune Surface Network Model

- Production Data, Manifold Pressures and Temperatures, Separator Pressures and Temperatures
  - Choke Model
  - Flow Correlation
  - Heat Transfer Coefficient
  - Separator Entrainment Factors
Optimization Scenarios

• Gas Lift Allocation
• Bottlenecks in Production / Injection Network
• Optimum Separator Pressures and Temperatures
• Optimum Flow in Parallel Flowline
• Various “What-if” Scenarios
• SPE 101089 : Presented in SPE AP Conf in Sept 2006
Real Time Production Optimization

• Morning Meeting
  – Discussion about Overall Production

• Production Related Issues
  – Well and Field Optimization
  – Regular Use and Maintenance of Various Spreadsheets
  – Best Utilization of Real Time Data
  – Engineers using applications in a standalone mode for offline optimization
  – Limited on-line information

• Solution??
Real Time Optimization Application: Requirements

- **Tune Well and Surface Network Model Automatically**
  - Linked Historian and SCADA

- **Visualization of Real Time Data**
  - For Trending and Identifying Anomalies

- **Analysis and Utilization of Real Time Data Using Engineering Application**
  - Field Optimization & Management, Forecasting

- **Web Application**
  - Results Available to Experts Anywhere in the World
Online Deployment

Real Time Solution

Server

- Production Data Management
- Network Model and Optimizer
- Reservoir Models
- Economic Parameters
- Well Perf Curves
- Well Models
- Pressure Transient Analysis
- Review, Approval

Production Tests

Targets

LAN/WAN/Internet/Intranet

Web Client

Engineer PCs

Completed
Production Reservoir

Data

SCADA Historian

Expired Data

Conditions, Status

Real-time Data

Historical Data

Optimized Set-points

Results

SCADA Server

Corporate Database

Data

Data
## Well Test Report: Last 24 Hours

### Production Well Tests in Last 24 Hours

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### Network report: Field 2 29/01/2009 16:00

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**Well Test Details**

- **Well name:** A-02
- **Test Start Time:** 09/03/2008 12:00:00

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**Recalibration Method:**
- PI Recalibration of well A-02 passed
- Recalibrated gas lift valve for well A-02

**PI**
- **L Factor:** 1
- **PI:** 0.74 STB/day/psia
- **Reservoir Pressure:** 3553 psia
- **FI (secondary):** 1.00 STB/day/psia
- **Reservoir Pressure (secondary):** 3038 psia

**Well type:** Gas Lifted

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**Detailed Well Test Report**

*Feb. 2 - 6, 2009 2009 Gas-Lift Workshop*
Location of Well Test on Well Performance Surface
Trending of Tuning Parameters
Tracking of IPR Curve
# Daily Monitoring using Real Time Data

![Image of Well Measurement Report]

### Table of Well Measurements

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<th>Date/Time</th>
<th>Well Name</th>
<th>Tubing Head Pressure (THP) measured (psig)</th>
<th>Lift Gas Rate (Qg) measured (MMscf/day)</th>
<th>Casing Head Pressure (CHP) measured (psig)</th>
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<th>Oil Production Rate (Qo) calculated (STB/day)</th>
<th>Gas Production Rate (Qg) calculated (MMscf/day)</th>
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Visualization of Optimization Results
Conclusions

• The typical optimization methodology for gas lifted well / asset is comprised of
  – Single Well Optimization
  – Full Field Optimization using Integrated Model
  – Real Time Optimization using Online Solution

• The online solution helps in reducing manual task by facilitating automatic tuning of integrated model.

• The tuned integrated model could be employed for production allocation, target monitoring, optimum choke and separator settings, etc.
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