MONITORING AND OPTIMIZATION

FOCUS
ORGANISATION
& PROCESSES

TROUBLESHOOTING

PRODUCTION MANAGEMENT
OPTIMISATION

• SURFACE FACILITIES
  • WELLHEAD/FLOWLINE CHOKES
  • SEPARATOR PRESSURES
  • COMPRESSOR DISCHARGE PRESSURE/THROUGHPUT

• SINGLE WELL PERFORMANCE CURVES
  • THEORETICAL/COMPUTER MODELS
  • MULTIRATE TESTS

• FIELD PERFORMANCE CURVES

• FIELD MODELS
FIGURE 5-1: Well Performance Analysis
Operating Rate vs Lift gas injection rate

- Water cut = 0 per cent
- Water cut = 25.000 per cent
- Water cut = 50.000 per cent
- Water cut = 75.000 per cent
- Water cut = 99.000 per cent

Operating Rate (STB/day) vs Lift gas injection rate (MMSCF/day)
DATA REQUIRED

- Test Separator pressure & temperature
- Oil, water & gas Flowrates (produced)
- WHFP
- WHFT
- Gas injection pressure (upstream)
- Gas injection pressure (downstream)
- Gas injection rate
- Total produced gas
- Discharge pressure & temperature from compressor
- Watercut
- Choke settings
WELL TEST PROCEDURES

- Single test
- Multi-rate test
REALITY CHECK!

• How & Where do you measure this data?
• How accurate is it?
• How accurate does it need to be?
INTEGRATING GAS LIFT / GAS COMPRESSION SYSTEMS

• Compression efficiency
• Back pressure on wells
• Suction pressure
• Discharge pressure
• Injection depth
• Production rate
• Valve mechanics
Possible Pressure Losses in Complete Production System

\[ DP_1 = P_r - P_{wfs} = \text{Loss in Porous Medium} \]
\[ DP_2 = P_{wfs} - P_{wf} = \text{Loss across Completion} \]
\[ DP_3 = P_{ur} - P_{dr} = \text{Loss across Restriction} \]
\[ DP_4 = P_{usv} - P_{dsv} = \text{Loss across Safety Valve} \]
\[ DP_5 = P_{wh} - P_{dsc} = \text{Loss across Surface Choke} \]
\[ DP_6 = P_{dsc} - P_{sep} = \text{Loss in Flowline} \]
\[ DP_7 = P_{wf} - P_{wh} = \text{Total Loss in Tubing} \]
\[ DP_8 = P_{wh} - P_{sep} = \text{Total Loss in Flowline} \]
Well Performance Curve
Lift Gas Injection rate vs Oil Rate

Oil Rate stb/d

Lift Gas Injection Rate mm/scf/d
CONSTRAINTS

- Gas
- Water
- Total Fluid
- Max fluid
- Max Revenue
- Max Cash flow
- Voidage replacement
FIND STABLE & OPTIMUM POINT OF INJECTION

- UNSTABLE GAS INJ. RATE
- THEORETICAL OPTIMUM GAS INJ. RATE
- OPTIMUM GAS INJ. RATE WITH SYSTEM CONSTRAINTS

PRODUCTION RATE (Qrate) vs. GAS INJECTION RATE (Qg)
Well Performance Curve for Input to Network Model

Lift Gas Injection rate vs Oil Rate

Oil Rate: stb/d
Lift Gas Injection Rate: mmscf/d
Delivery Pressure: psi

Graph showing the relationship between Lift Gas Injection rate and Oil Rate at different delivery pressures (20 psi, 86 psi, 152 psi, 218 psi, 284 psi, 350 psi). The graph illustrates how the production of Oil Rate changes with varying Lift Gas Injection rates at each specified pressure level.
NETWORK MODEL

Separator

Manifold

Wells
# GAS LIFT RANKING SHEET

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START UP AFTER SHUT DOWN

Accessing Optimised Production

Field Production, MBOPD

ShUTDOWN

Recovery

Steady State

“Tuning” of Plant & Wells
CONTROL ROOM DATA SET UP?

- Gas Injection Rate
- Choke setting
- Casing Pressure
- THP
- Water Cut
METHODOLOGY
Obtain Original Gains

- Well by Well
- Initial focus on immediate gains
  - Incremental gains / improved productivity
  - Lower opex
  - Lower cost per barrel
- Wellbore/production facility/Reservoir
- Typically 5 - 10% production increase / reduced cost per bbl
METHODOLOGY
Production Optimisation & Management System

- **Develop Optimization & Management System**
  - Full system modeling
  - Monitoring, Data acquisition & management
  - Training
  - Implement & sustain management system processes
  - Performance measurement & reporting
  - RTO / Automation?

- **Baseline Protection & Increased Value**
  - Typically 1-3% increment
  - Further reduce cost per bbl
METHODOLOGY
Look at Bigger Picture

- Work with reservoir optimization group
- Contribute to field development studies & planning
- Added value? Significant
UNLOCKING VALUE
INCREMENTAL & BASE PROTECTION

OIL PRODUCTION 1000s B/D

TIME

MAR    JUN    SEPT    DEC    MAR    JUN

POTENTIAL VALUE FROM OPTIMISATION

OPTIMISED BASELINE
ADDED VALUE

- Incremental oil
- Reduce costs
- Slow decline rate
- Improve strategic planning
- Extend field life / put off abandonment
- Increase recoverable reserves
- Improve cash flow
- Lower cost per barrel!
- Improve NPV
RULES OF THUMB FOR INCREMENTS FROM OPTIMISATION

Potential uplift to 25% +
- Well by well to 75%
- Full field to 20 + %
- Automation - real time - to 10%
AUTOMATION

- Real time data management
- Scada / telecommunication
- Remote control
- Open system
- Closed system
PRODUCTION OPTIMISATION & MANAGEMENT

Field Development & Planning
Field Ranking
Infill Candidates
Pattern Optimization
Recompletion
Well Stimulation
Lift Optimization

Response Time

Action

Opportunity Recognition

Surveillance

Diagnosis

Project

Opportunity Occurrence

Long-term Surveillance & Optimization

Real-time Monitoring & Production Mgmt.
NORTH SEA FIELD CASE STUDY

- Four normally manned platforms
- One not normally manned platform
- 79 producing wells
- 45 gas lift wells
- 19 ESP wells
NORTH SEA FIELD CASE STUDY
SYSTEM CONSIDERATIONS

- Sand production
- Drawdown limitations
- Produced water
- Water coning/preferential production
- Scale
- Gas capacity and availability
- Plant considerations
- Well start up
INCREMENTAL OIL

1998 Incremental Oil Rate from Gaslift Optimisation
Field Decline Rate applied to Instantaneous Gains per Well
Gains identified to end 4th quarter
IMPROVED STRATEGIC PLANNING

- Gas Lift Vs ESP
- Compression capacity
- Separator / compressor philosophy
- Separator / Prod. Optimisation
- Completion design
Improvement in Gas Lift Efficiency during 1998

Overlift is defined as the gas lift in excess of the optimum gas lift requirement

Well 41
Well 40
Well 20
Well 19, 38, 51
Well 55
Well 33, 43
Well 18, 37, 53, 56
Well 49
Two compressors
REDUCE DECLINE RATE

Field Oil Production 1996-1998

1997 Field Decline

EOR engineer commences work
GAS LIFT SYSTEM CONSIDERATIONS

• SAND PRODUCTION
• PRODUCED WATER
• WATER CONING
• ANNULAR SAFETY SYSTEM
• CORROSION EFFECTS
• HYDRATES
• ASPHALTENES
• BUBBLE POINT
• CHEMICAL INJECTION
• SCALE
• GAS CAPACITY AND AVAILABILITY
• CASING INTEGRITY
• RESERVOIR PERFORMANCE
• SYSTEM OPTIMISATION
• WELL STABILITY
• WELL START UP
• PLANT CONSIDERATIONS
• GAS QUALITY
• TRAINING