Plunger Lift Remote Surveillance Improves Shale Well Production

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XTO Operations Engineer

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Business Development
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▸ INTRODUCTION
▸ WELL SELECTION
▸ POWER OF SURVEILLANCE
▸ OPTIMIZING & TROUBLESHOOTING
▸ CONCLUSION
▸ ADDENDUM
INTRODUCTION
XTO Fort Worth Operations

OPERATIONS
• North/South Areas
• 7 Foremen
• 50+ operators
• 1900 wells
  Daily Averages
  • 900,000 Mcf
  • 110,000 Bbls Water
INTRODUCTION
2008 Dilemma

• Over 90% of wells in US are liquid loaded. (Marathon Analysis)
• Gas lift effective, yet costly. Overused.
• Venting and foaming agents inconsistent.
• 100 wells on stand alone PL. Limited results.
• Decided to explore plunger lift with remote monitoring and control.
INTRODUCTION
Objectives

PROCESS
• Installed 50 systems with telemetry from various suppliers.
• Utilized real time data for root cause analysis.

GOALS
• Improve production.
• Reduce downtime.
• Reduce operational cost.
• Rapid payback.
## INTRODUCTION

### Examples

<table>
<thead>
<tr>
<th>WELL # 1</th>
<th>PRODUCTION</th>
<th>DOWNTIME</th>
<th>VENTING</th>
<th>REPLACE PLUNGER</th>
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</thead>
<tbody>
<tr>
<td>BEFORE</td>
<td>148 Mcf / d</td>
<td>22 %</td>
<td>3 X per Wk</td>
<td>Quarterly</td>
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<tr>
<td>AFTER</td>
<td>186 Mcf / d</td>
<td>8 %</td>
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<tr>
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<td>(25.7% Increase)</td>
<td>(63.6% Decrease)</td>
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<td>BEFORE</td>
<td>82 Mcf / d</td>
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<td>Daily</td>
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<td>(158 % Increase)</td>
<td>(83.3% Decrease)</td>
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INTRODUCTION
Inclusive Lifting Cost ($ / Mcf)

<table>
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<th>LIFT METHOD</th>
<th>LIFTING COST COMPARISON ($ / Mcf)</th>
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<tr>
<td></td>
<td>MIN</td>
</tr>
<tr>
<td>Gas Lift</td>
<td>$1.04</td>
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<tr>
<td>Plunger Lift – No Telemetry</td>
<td>$0.25</td>
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<tr>
<td>Plunger Lift – With Telemetry</td>
<td>$0.19</td>
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</table>

- Lifting costs reduced up to 75% with automation!
- Optimization provides additional value, discussed later
- Downtime occurs at lower frequency and duration
- Coordination between field and office proved crucial
WELL CANDIDATE SELECTION

Signs of Loading

Critical Flow Rate

- Minimum flow rate at which liquid is carried to the surface.
- Experience indicates Turner under predicts onset of loading.
- Loading occurs down hole long before visible at surface.
- Guo et al. predicts critical rate based on down hole conditions
  - ~750 Mcf/d
WELL CANDIDATE SELECTION
Signs of Loading

- Erratic Production
- Liquid Loading
- Casing Pressure
- Line Pressure
- Plunger Lift Installed
- Erratic Production

Feb. 27 - Mar. 2, 2011
# WELL CANDIDATE SELECTION
Flow Rate vs Liquid Produced

<table>
<thead>
<tr>
<th>WELL</th>
<th>MCF/D</th>
<th>BBLS/D</th>
<th>GLR</th>
<th>LINE PRESSURE</th>
<th>LIFT PRESSURE (CP-LP)</th>
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<td>204</td>
<td>2.7</td>
<td>135</td>
<td>500</td>
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<td>Well # 2</td>
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<td>94</td>
<td>5.8</td>
<td>180</td>
<td>500</td>
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<td>Well # 3</td>
<td>300</td>
<td>61</td>
<td>4.9</td>
<td>140</td>
<td>720</td>
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<td>Well # 4</td>
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<td>540</td>
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<td>12.0</td>
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<td>300</td>
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<td>Well # 9</td>
<td>460</td>
<td>27</td>
<td>17.0</td>
<td>130</td>
<td>300</td>
</tr>
</tbody>
</table>
• Low GLR wells can prove difficult!

• Low GLR wells with higher flow rates are easier

Non-Productive Time (NPT) is Unplanned Downtime
• Leverage expert operator skills over many wells
• Daily pinpoint lease operator top priorities
• Remote manual close (weather, pipeline, tank levels)
• Real time alarm notification (tank levels, line pressure, fast arrivals, well shut-in, etc)
• Faster troubleshooting – DATA!
• Rapid leak detection
• Detect some EFM calibration issues
• Reduce equipment damage

NOW KNOW, ACT NOW, PROFIT MORE!
POWER OF SURVEILLANCE
Tools

Well Names

- Well Name: Piller Plugging
  - Time: 02/28/11
  - Production Mode: 13.0
  - Pressure: 529 psi
  - Flow: 35 Mcf

- Well Name: Bower Plugging
  - Time: 02/28/11
  - Production Mode: 13.0
  - Pressure: 575 psi
  - Flow: 35 Mcf

- Well Name: Larmer Plugging
  - Time: 02/28/11
  - Production Mode: 13.0
  - Pressure: 529 psi
  - Flow: 35 Mcf

WELL SUMMARY SCREEN
REAL TIME SNAPSHOT
PRODUCTION!

RIGHT INFORMATION
RIGHT FORMAT
ANYTIME
ANYWHERE

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Denver, Colorado
## POWER OF SURVEILLANCE

Tools

### Plunger Lift Cycle Report

<table>
<thead>
<tr>
<th>Run #</th>
<th>AT CLOSE</th>
<th>AT OPEN</th>
<th>RUN DATA</th>
<th>PRODUCTION DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pressure (psi)</td>
<td>Time</td>
<td>Pressure (psi)</td>
<td>Time</td>
</tr>
<tr>
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<td>02/01/11 07:54 AM</td>
<td>CP: 510, TP: 150</td>
<td>02/01/11 10:42 AM</td>
</tr>
<tr>
<td>5342</td>
<td>CP: 146, TP: 53</td>
<td>02/01/11 09:50 AM</td>
<td>CP: 508, TP: 147</td>
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<tr>
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<td>02/01/11 02:30 PM</td>
<td>CP: 496, TP: 135</td>
<td>02/01/11 10:42 AM</td>
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</tbody>
</table>

### Key Parameters

- **Cycle #**
- **Liquid Load (CP – TP)**
- **Lift Pressure (CP – LP)**
- **Close Time**
- **Plunger Velocity**

### Additional Information

- **Station Name:**
- **Report Range:** 02/01/11 08:00 To 02/02/11 14:43
- **Temperature:** 30°F
- **System Voltage:** 13.6 V
POWER OF SURVEILLANCE

Tools

- Flow Rate
- Casing Pressure
- Tubing Pressure
- Line Pressure

Detail Well History

- 12/21/09 20:00
- 12/21/09 20:30
- 2/21/09 21:00
- 2/21/09 21:10
- 2/21/09 21:20
- 12/21/09 21:30

- PSI
- MCF

TIME

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OPTIMIZING SHALE WELLS
Process

• **FOCUS ON PRODUCTION!**
• Use reliable hardware
• Minimize restrictions
  • BH Spring to pipeline
• Review on each cycle
  • Fluid in Tubing
  • Lift Pressure
  • Plunger Velocity
• Gas Produced
• Short afterflow on initial cycles
• Troubleshoot – DATA!

![IPR Curve](image)

• **OPERATE AT LOWEST POSSIBLE CP**
  • Many cycles each day
  • Open when fall time elapses
  • Fast falling plungers
  • Standing valves
OPTIMIZING SHALE WELLS

Examples

PROBLEM: ERRATIC PRODUCTION

Daily Well Production

LINE PRESSURE
FREE FLOWING
PLUNGER LIFT

PRODUCTION

Over 200% PRODUCTION INCREASE

05/30/09 05/06/09 06/13/09 06/20/09 06/27/09 07/04/09

Volume (Mscf) Static Press (psia)
OPTIMIZING SHALE WELLS
Examples

PROBLEM: ERRATIC PRODUCTION

NO TELEMETRY
TIME CONTROL

TELEMETRY
OPEN ON LIFT PRESSURE

17 % PRODUCTION INCREASE
## OPTIMIZING SHALE WELLS

### Examples

**Plunger Lift Cycle Report**

**Last Poll Time:** 13-FEB-11 08:48PM  
**Temperature:** 58°F  
**System Voltage:** 13.2 V

<table>
<thead>
<tr>
<th>Run #</th>
<th>Time</th>
<th>AT CLOSE Pressures (psi)</th>
<th>Fluid in Tbg</th>
<th>AT OPEN Pressures (psi)</th>
<th>Act. Lift</th>
<th>Req’d Lift</th>
<th>Time (min)</th>
<th>Velocity (ft/min)</th>
<th>Close Time</th>
<th>Open Duration</th>
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<td>1339</td>
<td>00:06</td>
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</tbody>
</table>

### PROBLEM:
**PLUNGER VELOCITY IS FAST**
Increase Afterflow or Decrease Close Time?

### Notes:
- **Fall Time** (15 min)
- **Close Time** (Much longer)
- **Lift Pressure** (220 psi)
- **Reduce Lift Pressure Will Shorten Close Time**. Plunger will make more cycles per day.
OPTIMIZING SHALE WELLS
Examples

PROBLEM: PRODUCTION BELOW TARGET

LINE PRESSURE

CONTROL SETTINGS CHANGE

20 % PRODUCTION INCREASE

PRODUCTION

OPTIMIZING SHALE WELLS
Examples

PROBLEM: PRODUCTION BELOW TARGET

LINE PRESSURE

CONTROL SETTINGS CHANGE

20 % PRODUCTION INCREASE

PRODUCTION
OPTIMIZING SHALE WELLS

Examples

PROBLEM: PRODUCTION BELOW TARGET

Fast Fall Plunger with Control Settings Change

Over 100% Production Increase
OPTIMIZING SHALE WELLS

Examples

PROBLEM: NO FLUID IN TUBING WHEN WELL OPENS

SHORTEN CLOSE TIME OR INSTALL STANDING VALVE. TUBING AND CASING PRESSURE EQUALIZE WHEN WELL IS CLOSED.
OPTIMIZING SHALE WELLS

Examples

PROBLEM: LIQUID PUSHED OUT OF TUBING DURING CLOSE

LINE PRESSURE

STANDING VALVE

PRODUCTION

26 % PRODUCTION INCREASE
Troubleshooting Shale Wells Examples

Problem: Possibly more fluid in the tubing on each run. May take longer to build casing pressure.

Motor Valve Leak. Tubing pressure decline and flow rate observed with well closed.
TROUBLESHOOTING SHALE WELLS

Examples

Line Pressure Leak: Line pressure is declining when well is closed. Typically liquid level controller or dump valve.

Problem: Missed arrivals. Lost production.

CASING PRESSURE

TUBING PRESSURE

LINE PRESSURE

FLOW RATE
TROUBLESHOOTING SHALE WELLS

Examples

**Problem:** Flow rate is not zero when well is closed.

- Casing pressure
- Tubing pressure
- Line pressure
- Flow rate
- Calibrate flow meter
CONCLUSION
Plunger lift improves shale production

• Shale well production dramatically improves when
  • Liquid is removed
  • Unplanned downtime is minimized
  • Plunger lift cycles are optimized

• Plunger Lift
  • Effectively removes liquid from shale wells
  • Is cost effective with a rapid payback
  • Is a long term solution

• Plunger Lift with Surveillance and Real Time alarms
  • Supplement field knowledge with in house “optimizers”
  • Provides real time data for root cause analysis

KNOW NOW
ACT NOW
PROFIT MORE!
ADDENDUM
POWER OF SURVEILLANCE
Tools

- Casing Pressure
- Lift Pressure
- Flow Rate
- Line Pressure
- Liquid Load
- Tubing Pressure
- Well Closes
- Well Opens
- Head Gas Produced
- Plunger Arrives
- Lateral Leg Unloads
OPTIMIZING SHALE WELLS
Examples

FREE FLOWING
PLUNGER LIFT

LINE PRESSURE

PRODUCTION

LEVEL AND STABLE PRODUCTION

PROBLEM:
ERRATIC PRODUCTION
OPTIMIZING SHALE WELLS

Examples

FREE FLOWING

PLUNGER LIFT

LINE PRESSURE

PRODUCTION

LEVEL AND STABLE PRODUCTION

PROBLEM:
ERRATIC PRODUCTION

OPTIMIZING SHALE WELLS

Examples

FREE FLOWING

PLUNGER LIFT

LINE PRESSURE

PRODUCTION

LEVEL AND STABLE PRODUCTION

PROBLEM:
ERRATIC PRODUCTION
OPTIMIZING SHALE WELLS

Examples

PROBLEM: ERRATIC PRODUCTION

FREE FLOWING

PLUNGER LIFT

LINE PRESSURE

PRODUCTION

29% PRODUCTION INCREASE

Daily Well Production

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Denver, Colorado
OPTIMIZING SHALE WELLS
Examples

**PROBLEM:** ERRATIC PRODUCTION

- **Line Pressure**
- **Free Flowing**
- **Plunger Lift with Telemetry Open on Lift Pressure**
- **Plunger Lift No Telemetry Open On Time**

**Production Increase:** 15%
OPTIMIZING SHALE WELLS
Examples

PROBLEM: PRODUCTION BELOW TARGET

INCREASE AFTERFLOW. PRODUCTION IS ABOVE CRITICAL AND RISING WHEN WELL IS CLOSED.

CASING PRESSURE
TUBING PRESSURE
LINE PRESSURE
FLOW RATE
## OPTIMIZING SHALE WELLS

### Examples

**PROBLEM:**
Production below target

**PLUNGER FALL TIME IS 15 MIN.**
Close time same as fall time.

**PLUNGER VELOCITY IS FAST.**
Increase afterflow.

**MONITOR PRODUCTION.**

### Table

<table>
<thead>
<tr>
<th>Run #</th>
<th>Time</th>
<th>Pressures (psi)</th>
<th>Fluid in Tbg</th>
<th>Time</th>
<th>Pressures (psi)</th>
<th>Plunger Rise</th>
<th>Arrivals</th>
<th>Open Duration</th>
<th>Close Duration</th>
<th>Gas (Mscf)</th>
<th>Liquid (Bbls)</th>
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</thead>
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OPTIMIZING SHALE WELLS
Examples

PROBLEM: PRODUCTION BELOW TARGET

LINE PRESSURE

CONTROL SETTINGS CHANGE

44% PRODUCTION INCREASE

PRODUCTION
OPTIMIZING SHALE WELLS

Examples

Problem: Production below target

Line Pressure

Production

Pad Plunger

Fast Fall Plunger

39% Production Increase

Daily Well Production

OPTIMIZING SHALE WELLS
Examples

Problem: Production below target

Line Pressure

Production

Pad Plunger

Fast Fall Plunger

39% Production Increase

Daily Well Production

Feb. 27 - Mar. 2, 2011

2011 Gas Well Deliquification Workshop
Denver, Colorado
PROBLEM: LIQUID PUSHED OUT OF TUBING DURING CLOSE.

STANDING VALVE

LINE PRESSURE

PRODUCTION

50% PRODUCTION INCREASE
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