Applications of Downhole Sensor System for Gas Lift Well Performance Evaluation and Optimization

Peter O. Oyewole and Jason Jones

This presentation is the property of the author(s) and his/her/their company(ies). It may not be used for any purpose other than viewing by Workshop attendees without the expressed written permission of the author(s).
What are we presenting?

- Downhole Sensor Package – Cable To Surface (CTS)
  - Description & Value

- Application to Gas Lift and Case Study
Phoenix Select Configuration – Gas Lift

Maximise draw down

Enables pressure build up transient analysis

Analyse injection point in real time

Single Pressure

Annulus Pressure
Tubing Pressure
Temperature
Vibration(x,y,z)
Current Leakage

Dual Pressure
Cable to Surface (CTS) Monitor

Equipment:
- ¼” SS Control Line
- Dual Pressure Gauge
- Ported Coupling
  - To measure pressure inside tubing
- Gauge Protector

Installation:
- Ported Coupling replaces collar at measurement point
- Gauge placed in ported coupling
- ¼” Control line from gauge to surface
- Surface termination point to read data
  - Can be transferred to SCADA or stored on memory stick
System Versatility

Well Head
- Csg Pressure
- Tubing Pressure
- Flow Line Pressure
- Water & Gas Rate

Well Site Control
- Pump Speed Optimization
- Pump Control
- Down Time

Flow Dynamics
- SBHP/FBHP
- ΔP (ESP/PCP)
- Vibration

PLC - SCADA
Value

• Allows for real time monitoring of downhole temperature/pressure
• Can validate conclusions made about lift point from traditional injection pressure data
• Allows you to see if you are getting the results from the reservoir that you expected.
The Case Study

Gas Lift Application with DH Sensor (CTS)
Why Gas Lift and CTS?

• Liquid loading problems

• Pump failures due to coal fines sticking pumps

• Low reservoir pressures
  - Concerns about low Pwf & Back pressure on the formation

• Aid in removal of significant amounts of coal fines
  - Coal filters@ the inlet of the Separator
Gas Lift
Completion objectives

— Prevent coal fines from clogging valve/orifices

— Minimize flowing bottom hole pressure
  • CBM reservoir requires very low Flowing BHP to maximize production rates

— Monitor Gas Lift System with downhole sensors.
  • Obtain Temperature and Pressure measurements to optimize production.
  • Allows for performance evaluation
Design Limitations/Requirements

• Pressure
  — Surface Injection pressure available: Less than 300 PSI
  — Static bottom hole pressure = Low (less than 200 psi)
  — Flowing bottom hole pressure = Low (less than 200 psi)

• Wellbore Configuration
  — 5 ½” 15.5# Liner & 7” Casing
  — Perf Depth 2845’ – 3200’
  — Injection rates of 1500+ MCF/D may be required
Completion and GL Design Interaction

• Annular Flow GL design
  - Annular flow design to prevent valve plugging
  - Annular flow to enable CTS application w/downhole sensors
  - Gas injection through tubing
  - Wellbore Fluid + Injected Gas produced up the Casing/tubing annulus

• Gas lift valve placement in the tubing
  - Orifice valve w/check valve run deep into the perforations to minimize formation backpressure & maximize production
  - Dual Orifice setup to allow for high injection volumes with less pressure + back up valve.
  - IPO valve (TRO =280#) run above orifices as contingency + initial Well Kick Off
  - IM Mandrel
Completion and GL Design Interaction

- **Tubing size selection**
  - 2 3/8” tubing inside of 5 1/2” Liner & 2 7/8” in 7” casing with Bull plug
  - Annular flow will prevent coal fines from entering valves

- **Temperature/Pressure Monitor**
  - Measure pressure in the tubing and casing @ the same depth
  - Placed near operating valve to measure ΔP across orifice


Wellbore Diagram

**Previous Production**
On Rod Pump, coal fines causing problems
750 MCF/Day

**Current Production**
25-40 B/D Water
1.3-1.5 MMCF/Day
Pcog = 16 Psi
Ptdg = 250 Psi
Injecting 600 MCF/Day

**Downhole CTS Monitoring for Annular Flow CBM Application**

2 7/8\" Tubing to 2666'
2 3/8\" Tubing
7\" Casing
5 1/2\" Liner @ 2705'
1\" GLV's
Perfs 2045' - 3200

1/4\" Stainless Communication Line

5 1/2\" Liner 2705'

Depth
2900'

CTS Tool
3148'
3184'
3188'

Feb. 4 - 8, 2008
What do you need?

• A high injection gas rate to be above critical rate for annular (casing) flow
  - Need sufficient injection rates & pressures
• Annular Side Pocket Mandrel (SPM) is much more preferred over IM due to ID restriction & ease of valve change out
• Downhole Pressure Sensors for optimization
Data

- Two downhole pressure points & two surface pressure points
- Production Conduit Gradient: as low as 0.013psi/ft (CP =14.4#, DHCP=56.8#)
- Injection Gas Gradient: ~0.008psi/ft
- Pressure drop across orifice: as low as 67psi during gas injection.
- Actual data close to model results
RESULTS

• Increased Production & Reserves
• Eliminated production losses due to pump failure and downtime for interventions
• Project (installation/operation of GL equipment) provided good economic returns
• CTS provided data for well performance monitoring and optimization
What did we present?

- Downhole Sensor Package – Cable To Surface (CTS)
  - Description & Value
- Application to Gas Lift and Case Study

Questions ????
Rights to this presentation are owned by the company(ies) and/or author(s) listed on the title page. By submitting this presentation to the Gas-Lift Workshop, they grant to the Workshop, the Artificial Lift Research and Development Council (ALRDC), and the American Society of Mechanical Engineers (ASME), rights to:

- Display the presentation at the Workshop.
- Place it on the www.alrdc.com web site, with access to the site to be as directed by the Workshop Steering Committee.
- Place it on a CD for distribution and/or sale as directed by the Workshop Steering Committee.

Other uses of this presentation are prohibited without the expressed written permission of the company(ies) and/or author(s) who own it and the Workshop Steering Committee.
Disclaimer

The following disclaimer shall be included as the last page of a Technical Presentation or Continuing Education Course. A similar disclaimer is included on the front page of the Gas-Lift Workshop Web Site.

The Artificial Lift Research and Development Council and its officers and trustees, and the Gas-Lift Workshop Steering Committee members, and their supporting organizations and companies (here-in-after referred to as the Sponsoring Organizations), and the author(s) of this Technical Presentation or Continuing Education Training Course and their company(ies), provide this presentation and/or training material at the Gas-Lift Workshop "as is" without any warranty of any kind, express or implied, as to the accuracy of the information or the products or services referred to by any presenter (in so far as such warranties may be excluded under any relevant law) and these members and their companies will not be liable for unlawful actions and any losses or damage that may result from use of any presentation as a consequence of any inaccuracies in, or any omission from, the information which therein may be contained.

The views, opinions, and conclusions expressed in these presentations and/or training materials are those of the author and not necessarily those of the Sponsoring Organizations. The author is solely responsible for the content of the materials.

The Sponsoring Organizations cannot and do not warrant the accuracy of these documents beyond the source documents, although we do make every attempt to work from authoritative sources. The Sponsoring Organizations provide these presentations and/or training materials as a service. The Sponsoring Organizations make no representations or warranties, express or implied, with respect to the presentations and/or training materials, or any part thereof, including any warranties of title, non-infringement of copyright or patent rights of others, merchantability, or fitness or suitability for any purpose.