Intelligent Agents for Gas Lift Monitoring and Diagnosis

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Overview

• Use realtime data to:
  • Analyze and diagnose cont. gas lift wells
  • Identify abnormal conditions
  • Recommend actions
  • Estimate performance gains
  • Enable management-by exception (MBX)

• Leverage world-class technology used in:
  • Finance
  • Defense
  • Intelligence
Why Do It?

- Gas lift a proven, widely-used AL method
- Responsible for a significant amount of production
  - 2003: ExxonMobil (31% of liquid), Shell (25% of liquid)\(^1\)
- Significant potential uplift/savings in most assets
- OPEX/BOE is low

\(^1\)Gabor Takacs, *Gas Lift Manual*, p. 6
Where is the value?

- According to Mr. Pareto: 80% of outcomes from 20% of events
Barriers to Optimization

- Monitoring gas lift systems is problematic because...
  - Data overload
  - Limited domain expertise
  - Competing priorities
  - GL “works” even when it’s broken!
The Goal

Analysis

Surging multi-point injection. Gas is being injected through valve #7, which is not the deepest valve in the well. Valve performance analysis suggests that valve #6 may be cycling open and closed.

Recommendations

Consider replacing valves to establish single point injection and to replace valve #6 which is cycling open and closed. Estimated production increase is 227 bbls/d.
Data Requirements

- Casing head pressure
- Tubing head pressure
- Gas injection rates
- BHP, BHT
- Flowing pressure, temp gradients
- Annular fluid level
- Production rates
  - Oil
  - Water
  - Gas
- GLV data
- Well performance data
Our Solution

- **Monitoring**
  - Leverage IAC’s work on pattern recognition from other projects, particularly for conditions such as heading

- **Diagnosis**
  - Built knowledge base to capture all potential conditions
  - Combination of measured data and calculated attributes
  - Over-defined system
  - Not-hierarchical

- **Overall Approach**
  - Deterministic
  - Probabilistic
  - Trainable
Scope of Knowledge Base

- Addresses continuous gas lift for IPO and PPO systems
  - ~ 60 different conditions encompassing
    - Inlet issues
    - Outlet issues
    - Downhole issues
  - ~ 15 attributes are monitoring including
    - Flow state
    - Valve state (open / closed / back-checked)
    - Qgi
    - Casing / tubing heading
    - Performance curves
    - ...others
Intelligent Agents

Intelligent Agent: Definition
- Computational entity: software or robot, perceiving and acting on its environment, autonomous in its behavior, at least partially depends on its own experience.

Characteristics
- Fast
- Robust
- Trainable
Associative Memory Technology
How We’re Doing It

1. Start
   - Time-series casing & tubing pressures
   - Other time-series data
   - Well Configuration (valve, etc)
   - Model Inputs (valve calcs, VLP, Perf curve, others)

2. Heading detection
3. Anomaly detection
4. Analysis Knowledge base
5. Gas Lift system state

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Next Steps

- Currently Forming JIP
  - 3-4 members + WFT
  - Est. time to complete = 1 yr.
  - Work to commence once membership requirements met
  - Integration w/ systems analysis s/w
  - Integration w/ realtime s/w
  - Field testing using live data
Q&A