Improving the Reliability & Maintenance Costs of Hydraulically Actuated Sucker Rod Pumping Systems

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Overview

• What is a Hydraulic Rod Pump?

• Brief History of Hydraulic Rod Pumps

• Design & Engineering Tradeoffs

• Examples of Maintenance Improvements
What is a hydraulic rod pump?

- Hydraulic cylinder actuates the sucker rods
- Bolt on replacement for traditional systems
- Long Stroke Capability
- Easy Stroke Rate Adjustment

Identical Downhole Assembly
A brief history of hydraulic rod pumps

• First developed in the 1940’s
  – Originally developed for the long-stroke capability
  – Deep, high volume, or troublesome wells*
  – Early Systems
    • Centrifugal, high volume, low pressure hydraulics
    • Positive displacement, low volume, high pressure
• 1970’s & 1980’s – Counterbalance
  – Shorter stroke lengths, more complex
• Many different systems & manufacturers

*D.M. Jones, 1950
Why have they not been commercially viable?

- ~65 years and dozens of manufacturers
- Macroeconomic fluctuations in the market
- Lack of support & training
- Niche market

Leaks & Maintenance!
No External Leaks

• Submerged polished rod
  – Integral stuffingbox / hydraulic seal
  – No external wellhead leaks

• Leaks are contained in production lines
• Cross contamination of fluid possible
  – Need extremely robust hydraulics
Leaks Cleanly Recycled

- Most hydraulic leaks are not critical failures
  - O-rings drip, hoses weep
- Unrepaired leaks eventually cause shutdown
  - External leaks make a significant mess

Locate hydraulic components in the tank to capture minor leaks safely and cleanly.
Design & Engineering Tradeoffs

- Ideal hydraulic sucker rod pump system:
  - Ultra Long Stroke (288”... 336”)
  - Simple (easy to maintain)
  - Mechanically efficient @ surface (i.e. counterbalanced)

- Pick two.....

- Our approach:
  - Ultra Long Stroke
  - Simple & Reliable
Long Stroke

- Reduced downhole wear and tear
- Better surface to pump stroke ratio
  - Less cumulative stroke inches lost to stretch
- Better gas handling characteristics

\[
\text{Compression Ratio} = \frac{\text{Swept Vol} + \text{Unswept Vol}}{\text{Unswept Vol}}
\]

- Structural & torque limitations
  - Large pumpjacks are mechanically limited
  - Hydraulics have no “damaging” torque limitations
Simple & Rugged

- How complex can they get?
- Simple may not always be better, but it helps.
Simple & Rugged

- Simple hydraulic valving
  - Easy to troubleshoot & repair
- No sensors at the wellhead*

- Polished rod contacts both produced, and hydraulic fluid
  - Necessitates highly contamination tolerant hydraulics
  - Limits exotic control mechanisms – Must be simple & durable

- Rotary vane hydraulic pump
  - Inexpensive & extremely tolerant of solids in hydraulic fluid

*Patent Pending
Preventative Maintenance

- Rubber components deteriorate (Hoses & O-rings)
  - Cause leaks and loss of production (i.e. shutdowns)
  - Fix leaks before they cause damage
- Ensure consistent training & support
- Neglect breeds contempt
  - A unit in severe disrepair is difficult to justify extensive repair
  - Repair small problems before they turn into big ones
Conclusion

• Hydraulic systems have improved
• They still leak, but can be properly contained
  – Prevent external messy leaks
  – Minimize low-oil shutdowns
• Long stroke is particularly suited to some wells
  – Other lift methods might have been the only choice
• No external moving parts – “More Safe”
• Easy install – Portable
  – No concrete pad required, Bolts directly to the wellhead
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