Improved Hydraulic Tubing Anchor Design

Bob Smithwa
Black Gold Pump & Supply
http://blackgoldpump.com
Overview

• What is a hydraulic tubing anchor?
• Why use a hydraulic tubing anchor?
• Hydraulic Anchor Components
• Case Study
• Engineering a better anchor
• Conclusion
Tubing Anchors – General Overview

- Stabilize pump motion relative to sucker rod
What is a hydraulic tubing anchor?

- Designated as “R” type anchors
- Holds the tubing to the casing
- Reduces wear on:
  - Sucker Rods & Couplings
  - Tubing
  - Casing
- Reduces stress and vibration
- Increases production
  - Increases bottom hole plunger travel
Why use a hydraulic tubing anchor?

- Simple Install & Removal
- Reduced likelihood of stuck anchor
- Minimal skill or experience needed
- Rebuildable/Repairable

- Casing gas can easily flow
- Mandrel bypass allows capillary tubes
How they work

• Where to Install:
  – 2 to 4 joints above the shoe or seating ring
  – Place drain 1 to 2 joints below the anchor
  – Place anchor above the perforations

• To Activate:
  – +70 PSI pressure differential (tubing\rightarrow\text{casing})
  – When pressure in the tubing string is greater than the pressure in the casing (+70 PSI), the anchor is activated

• To Retrieve:
  – Unseat the pump or blow the drain
  – Anchor releases when the tubing pressure is equalized
Hydraulic Anchor Components

- Live Slip
- Piston & Seal Cup
- Guide
- Sleeve
- Mandrel
- Collar
- Patent Pending
- Fixed Slip
How did we get here?

• Hydraulic anchors were failing under extreme conditions
  – Hydraulic anchors were the operator preferred anchor type

• Needed to improve existing anchor designs
  – Fix the flaws, improve runtimes

• Case study: Approximately 80 wells
  – Deep, long stroke mechanical systems
  – Relatively high stroke rates – Extreme operating conditions
  – Anchors from two manufacturers
Design Flaws – Existing Anchors

- **Machining process – Insufficient tolerance specification**
  - Piston-to-Bore clearance was inconsistent
  - Machined surface finish – Insufficient plating adhesion
- **O-ring groves improperly spec’d for application**
  - Too loose, Too tight – very inconsistent
- **Piston Over-travel**
  - Existing anchor size options incorrectly applied to various casings
- **Assembly Procedures**
  - O-rings damaged on installation
Machine Process – Surface Finish

Old
Rough Surface

New
Smooth Surface
Assembly Process

Sharp edges damage O-rings on assembly

De-burred edges

Old

New
Insufficient Tolerance Specification

Piston rocking & Sleeve washout

Specify Tolerances

Improve machine shop compliance
Piston Over-travel

Mechanically Limit Piston Travel

More Mandrel Sizes for Various Casing Sizes
O-ring Issues

- Properly size o-ring grooves according to industry specs
- Tighter Machined Tolerances
- Proper Handling
Engineering a better anchor

• Improved machined tolerances
  – Consistent Piston-to-Bore Clearance
  – Reduced Piston-to-Bore Clearance

• Properly specified o-ring groove dimensions

• Limit piston travel
  – More sizes for better casing fit
  – Mechanical stop/limit

• Machined surface finish
  – Better adhesion of plating
  – Better for sealing surfaces
Selecting the right anchor

• To start you need to know:
  – Fluid Level, Casing Size, Casing Weight, Tubing Size, Pump Bore, Pump Depth, Anchor Depth, Well Temperature

• Load – Thrust Calculation:
  – Must have Thrust > 130% of Load
  – Two anchors “DR” can be used if not > 130%
  – DR anchors must be separated by 1 to 2 joints
Conclusion

• Hydraulic anchor components engineered to perform
• Increased runtimes
  – Too soon to draw final conclusions
  – Results so far are very promising
• No design-related failures
  – One instance of a split o-ring
    • Likely due to assembly error
    ✓ Assembly process amended
• Pulled anchors look good
  – (Pulled due to unrelated well work)
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