Analyzing & Troubleshooting Plunger Lifted Wells

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When Shut-in Begins the Tubing Pressure Drops as Plunger Starts to Fall

Pressure Drop = Weight / Area

Pressure Drop = 2.4 psi

Plunger weight (8 lbs) / Area of 2-3/8”
Pressure Drop = \frac{Weight}{Area}

Plunger weight (8 lbs) / Area of 2-3/8”
Sometimes Easier to See Plunger Fall through Liquid by Examining the Tubing Pressure Signal.

**Tubing Pressure Increases when Plunger Stops**

arrow pointing to a graph showing pressure spikes.

- **Hits Liquid**

- **Pressure Kicks as Plunger Falls through Liquid**

**Usually See Collars in Liquid when Pressure is High.**

**Adjustable By-Pass Plunger**

0.4 Psi
Tubing Pressure Helps to Identify Downhole Problems

Plunger falls Past Hole at 1872 feet and Pressure from Casing Flows Into Tubing

~ 3 psi Drop when Released from Catcher
Hole in Tubing 59th Joint

Rapid Tubing Pressure Increase if Plunger has Sudden Stop

Suddenly Starts Suddenly Stopped
Plunger’s Weight is Supported by Tubing
Pressure Show Standing Valve Required

Casing - Tubing Pressure Only Due to Plunger Weight on Gas

Little/No Liquid Brought Up by Plunger

At this Point All Liquid is Pushed out of Tubing

All Liquid Pushed Out of Tubing, Since Tubing Equal to Casing Pressure
Standing Valve in Well Changes How Pressure Equalizes Between Tubing and Casing

- Tubing Pressure Increases when Standing Valve Opens to Allow Liquid and Gas In
- ZOOM In to End of Shut-in Period
  - 0.4 Psi
  - Tubing Pressure Stair Steps
  - Tubing Pressure Increases when Standing Valve Opens to Allow Liquid and Gas In
Blocked Intake into Tubing

- Tbg Pressure Slow to Build
- Rapid Tbg Pressure Decline
- Casing Pressure at start should have surfaced plunger in 1.89 minutes – instead plunger took 23 minutes to surface
Need to Stimulate Damaged Formation

Formation Damaged
~ Pressure Drops with Each Cycle

Fall Velocity Increases as Pressure Drops
See Pressure Changes

0.5 PSI

Tubing and Acoustic Signal Show Plunger Fall Past Tubing Collars

Zoom in to 0.3 minutes
Can see Plunger Going by Collars

Acoustic and Tubing Signals Show Plunger Fall

Axis Display 300 Seconds of Data
Shot Down Casing Should Show Liquid Level near Tubing Intake Depth of 6816’

Well Flowing up Tubing, Shot Down Tubing/Casing Annulus Shows LL @ 5213 ft with Tubing Intake 6816 ft.

Use 0.6616 Gas SG for Distances
Up-kick at Same Depth in Tubing/Casing
Well Shut-in 1.5 Hrs, Shot Down Tubing

Likely Hole 3724.6 Feet

Liquid Level

Counted Collars for Distances

3724.58 ft
Gas Well Production Curve - Flow Rate

04/30/07 Liquid Loading supported installing plunger

6/6/07 plunger equipment was installed and then realized a hole.

Service rig 7/27/07 Replaced tubing; more sand troubles; plunger working now
1. Well was Liquid Loaded
2. Fluid Level Shots Showed Tubing was OK
3. Installed plunger and couldn't surface the plunger
4. Took more tbg shot's.
5. Then the upkick showed up in the tbg as the well was shut in for a while.
6. Original shot's did not expose the hole in the tbg as the well was loaded up with Gassy Liquid Above Hole

Hole in Tubing (No Blast Joint) Cut by Gas Flow From Upper Set of Perf’s
Shots Down Tubing & Casing

Hole in Tubing @ 6868'

Tubing Pressure
228.8 psi (g)

Tubing Pressure Buildup
0.036 psi
1.75 min

Gas/Liquid Interface Pressure
268.6 psi (g)

Liquid Level Depth
MD 6919.46 ft

Tubing Intake Depth
MD 8283.27 ft
TVD 8283.27 ft

Formation Depth
MD 8299.70 ft

Reservoir Pressure (SBHP)

Producing Gas Flow
1 Mscf/D

% Liquid
95

Liquid Below Tubing
Oil 0 %
Water 100 %

% Liquid Below Tubing
99 %

Tubing Intake
856.0 psi (g)
PBHP 863.3 psi (g)

Casing Shot

Tubing Shot
Tbg Press Change When Plunger Falls Past Hole

Plunger Fall Velocity Gradually Increases?

Plunger Hits Liquid @ 6945'

Drop Plunger to Count Joints to Hole
Failure ~ Just 1 Small Hole

1) Hole was 156 jts from surface or 5054' based on 32.4' joint lengths

2) Hole measured with micrometer to be 0.160” by 0.125”.
Maintenance

- Plungers
  - Pad Type
    - Check for Looseness and Wear
  - Brush Type
    - Gauge O.D. with Gauge Ring Or Caliper (Temperature limits)
  - Bar Stock (use only as last resort)
    - Gauge with Calipers
  - Two Piece
    - Check Ball for indentations, sleeve for wear

- Lubricator Shock Spring
  - Visual Inspection and Looseness in Catcher

- O-Rings
  - Visual Inspection, Leaks

- Controller
  - Fuse Link, Ground
  - Module
  - Battery
  - Latch Valve

- Sensor / MSO (Magnetic Shut Off)

- Filter Element

- Automated catcher if present
Plunger System Tracking

- Keep a History
  - Cycles / Trends
    - Optimize Production and Minimize Operator Time
  - Plunger Changes
    - Get most efficient use and life from plunger
    - Optimize Profit
  - Surface Shock Spring
    - Optimize Plunger Life
    - Reduce Cost (Spring Costs Much Less Than Plunger)

- How to Track
  - Controller Cycle Forms
    - Plunger System Tracking Forms
  - Plunger well data linked directly to a database
  - Record # cycles or mileage such as 10,000-15,000 miles?

- Failure Analysis
  - Determine the life span of plungers/shock springs
  - Reasons for frequent plunger changes
- Track Plunger Failures
- Budget, preventive maintenance, save money
- Consider monitoring mileage travel of plungers before change out
Do you want a Standing Valve?

- On every well
- Any time the tubing and casing pressure get closer together during shut-in
- Do NOT notch, cut a little scratch
- Use SV with spring, so that you can add pressure and push it out

Do you want to use surfactant with plunger?

Surfactant foam can lift sand and sand can stick plunger.
PLUNGER LIFT TROUBLES:

- FAST PLUNGER ARRIVAL
- SHORT LUBRICATOR SPRING LIFE
- SHORT PLUNGER LIFE

☑️ Often Caused by Plunger Arriving Dry

- Best Fixed by using Standing Valve @ Bottom to Keep Liquid in Tubing During Shut-in Time Period
  - Use Bumper Springs
  - With Standing Valve
  - Notch standing valve (May Leak Too Much)
  - Use new Spring Loaded Standing valve technology

Standing Valve with Spring Loaded Ball & Seat will Hold Fluid in Tubing, but Opens and Dumps Fluid with Too Much Fluid Load
Where do you set EOT?

- Adjacent to best gas producing zone.
- Run as deep as possible, where plunger will still cycle
- Move deeper and stop at bottom of perforations

What about a packer?

- Take Out
- Use to Protect Formation when Killing Well
- If a long away from perfs, may present a unloading problem
Tubing Intake Vs. Perforations

Tubing Intake Set Depth with MULTIPLE PERFORATED INTERVALS or MASSIVELY THICK RESEVOIRS is CRITICAL

• Intake TO DEEP Causes
  • Excessive Fluid Transfer from the Annulus when plunger Open Cycle is initiated can cause:
    • Loss of Gas Differential Pressure Interface on Plunger causing no arrivals
    • Tubing can Load Up

• Intake TO SHALLOW Causes
  • Excessive Back Pressure on formation
  • Damage to Formation
What do you do if well loads up?

- Operate controller in swab mode, with little/no afterflow. Once arrival velocities become too fast, then add afterflow to slow down.

When can a tubing extension/flow tube be bad?

- When pressures are low and gas velocity are too high
- Then debris can be sucked into tubing
What do you do if casing is 2 7/8?

- Try plunger lift and control on velocity
- Run tubing stop with bumper, conventional plunger, check for sand and cleanout if needed

How big should port be in control valve?

- As big as possible, do not want restrictions to flow
- Then debris can be sucked into tubing
Facility Considerations

• Don’t bring on all wells at once
• Use of by-pass type of plungers will upset wells much less than use of conventional plunger lift
• Low pressure separators and low pressure lines are better for plunger
• Do Not cause flow restrictions with small lines or bends or elbows at the wellhead
Pressure Considerations

- If surface line pressure increases during the pressure build-up portion of the cycle, then plunger may not surface.
- Near-by wells or New Wells interfere with other wells by raising line pressure.
- Compressor gas capacity may increase well pressure.
- Short “complete” cycles maximize production.
Pressure Considerations

- Plunger Lift works better with low sales line pressure
- Casing Pressure must increase during Shut-in to build sufficient energy to bring accumulated liquid and plunger to surface.
- Casing Pressure too high & fast plunger velocity slips liquid, waste energy and damages equipment
  - Less Production
- Casing Pressure too low plunger may not surface
  - More production
- Pressure build-up must be controlled for optimum Plunger Lift System Performance
### Troubleshooting Guide

**Develop on a Field by Field Basis**

**PLUNGER LIFT TROUBLE SHOOTING GUIDE FROM Phillips/Listiak**

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Safety

- When at well, Know the Location of the Plunger by Tracking Plunger
- Excessive impact force will cause even the best lubricator to fail.
- Worn springs and excessive plunger velocities can lead to failure
- Screwed joints on wellhead can come loose with hard plunger impacts.. Flanged joints may not solve problem
- Large diameter plungers most dangerous
- High casing pressure cycles are most dangerous
- Low liquid producers are most dangerous.
- If stuck and high casing pressure and low tubing pressure, it could be hydrate problem.. Inject Methanol before opening or it could release suddenly causing damage.
- Never look down the tubing when well open.
- Listening to well with ear on well to sense arrival could be dangerous if well head fails
PLUNGER LIFT TROUBLES:

1. Some Suppliers incentive is to sell equipment and do installs.
2. Service and support often is not available.
3. Some operators are uncomfortable with plunger lift
4. Some operators do not maintain up-to-date service/inspection/maintenance records.
5. Training often to General – More Job specific training needed.
6. Controllers too complicated - Plunger performance is dependent on the operators interaction with all of the elements: the plunger, surface equipment, down hole assembly, produced fluids, wellbore, and the reservoir.
PLUNGER LIFT Problems: Hardware

1. Short Lubricator Spring Life
2. Short Plunger Life
3. Solid Plungers are often inefficient
4. Fast are very under-utilized
5. One of the biggest issues is incorrect measurement; Often EFM and RTU changes result in erroneous gas measurement
6. No standing valve or Leaky standing valve have been reported to account for 80% of all plunger lift failures
Problems Faced in Optimizing/analysis of plunger lift installations OR identifying a liquid loaded well

1. Rely on information given to me
2. Lack of data.
3. Interpretation of the data.
4. Plunger fall time
   - if plunger is making to bottom
   - rate it is falling in relation to gas flow.
5. Plunger speed
6. Dry runs
7. Plunger not bringing fluid/not traveling
8. Shut-in time to bring fluids to surface
Plunger Lift Problems - Optimization

1. How to Optimize Well
2. Not knowing where the plunger is
3. What is the plunger doing during a cycle
4. Not knowing what is going on down hole..
5. Getting the plunger box programmed
6. Getting the plunger to bottom by shut off time
7. Not have the well shut in to long or short
8. Flowing the well to short or to long.
9. Getting the best cycles on a well.
Plunger Lift Problems - Well

1. Need to know if plunger makes it to bottom with sand and salt in tubing.
2. Hydrates in well bore.
3. Cold Temperatures.
4. Large water rates.
5. Liquid loading and sand.
6. Liquids on wells and loading up.
7. Liquid loading, freezing, low pressure.
1. Operator time
2. Do not maintain up-to-date service/inspection/maintenance records.
3. Some operators are uncomfortable with plunger lift
4. Pumpers set controller for their convenience.
5. Use general settings for all plunger lift gas wells with no concern for optimization.
6. Getting pumpers and foreman to buy into recommendation. Hard to convince them.
7. Employees not knowing how plunger operates or how to adjust accordingly.
8. Training often to General – More Job specific training needed.
Conclusions for Analyzing & Troubleshooting Plunger Lift Operations

1. Plunger fall velocity can be accurately measured with an acoustic instrument,

2. Minimum shut-in time for the plunger lift installation can be determined.

3. Plunger fall measurements will ensure that the plunger will reach the fluid at the bottom of the tubing by the end of the shut-in period.

4. Holes in the tubing are identified by observing changes in the plunger fall velocity and in the tubing pressure.

5. Use the correct plunger for the well ~ High pressure from long shut-ins can reduce gas rate.