Tubing Backpressure Sometimes Required on Gassy Sucker Rod Lifted Wells

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Presenting Data Showing Impact of Gas Up Tubing on Sucker Rod Lifted Well

1. Field Dynamometer Data Collected on a Gassy Sucker Rod Lifted Well
   a) Having Pump Problems because too Much Gas is Being Pumped up the Tubing
   b) Tubing Unloads while Acquiring Dynamometer Data
   c) Pump Action Stops.
   d) Various Pump Conditions based on Dynamometer Card Shapes will be Shown.

2. Dynamometer Data was Acquired Using a Calibrated Horseshoe Load Cell
On a Well Producing a Lot of Gas. What does it mean? When:

- **Gassy Fluid Level Near Surface**
  - Casing Pressure: 171.6 psi (g)
  - Casing Pressure Buildup: 59.1 psi, 15.00 min
  - Gas/Liquid Interface Pressure: 172.3 psi (g)
  - Liquid Level Depth: 126.50 ft
  - Pump Intake Depth: 4,997.00 ft
  - TVD: 4,997.00 ft
  - Formation Depth: 6,565.00 ft

- **Well State**: Producing

- **Liquid Below Tubing**
  - Oil: 0 %
  - Water: 100 %

- **Pump Intake Pressure**: 531.7 psi (g)
- **PBP**: 875.5 psi (g)
- **Reservoir Pressure (SBHP)**: 1,800.0 psi (g)

- **No Pump Action ~ Weigh Rods in Air**
  - Subtract Weight Rods in Air and Pump Card on Zero Load Line

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Calculated Pump Card Loads:

**SV Open Upstroke:**

\[ \text{Fo Max} = (P\text{dis} - 0) \times \text{Ap} \]

\[ \text{Fo} = (P\text{dis} - \text{Pintk}) \times \text{Ap} \]

**TV Open Downstroke:**

\[ \text{Fo} = 0 \]

Pump Card Reference Lines:

1. **Fo Max** - assumes pump intake pressure is zero, where well provides no help in lifting the fluid to the surface.

2. **Fo From Fluid Level** - assumes pump intake pressure determined from fluid level shot, where well’s PIP provides help in lifting the fluid.

3. **Zero Load Line** – pump card sets on zero load line because rods in tubing fluid with pressure above and below the plunger equal; no friction due to fluid displacing through TV on down stroke
Steps C - D in Pump Operation

Pump acts as a Compressor

PDis - Discharge Pressure
PB - Pressure in Barrel
Pintk - Intake Pressure

C) Standing Valve closes, when plunger reaches top of stroke, rods start to un-stretch to transfer fluid load, Fo, from rods [C] onto tubing [D].

D) Traveling Valve Opens when pressure in pump barrel >= Pump Discharge Pressure, PDis.

C-D) Plunger applies pressure to fluids inside pump barrel, to compress fluids in Pump barrel and increase pressure.
No Pump Action Shown as Flat Pump Card Load Lines

1) **TV Stuck Open** - Pump card on Zero Load, Looks like Deep Rod Part but often can tag or jar the rods and knock the debris out of the pump and re-start pump action.

2) **SV Stuck Open** – Plots on the Fo from the Fluid Level line

3) **Tubing Blown Dry** – Missing Buoyancy, plots as a flat line @ a height of Wra-Wrf lbs above the zero load line.

![Graph showing pump card load lines](image-url)
Gas Filled Pump Card Means that Free Gas is Being Pumped up the Tubing

Strokes 1-146 gas interference ~ gas pumped into the tubing

Stroke 147-186 No Pump Action

TV Stuck Open!
Gas Through the Pump Can Interfere with the Normal Valve Action

Stroke 187 TV Delay Going on Seat

Stroke 188 More Gas Up the Tubing

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Flat Pump Card Means No Load Transfer Between SV and TV

Stroke 189 Pump Full of Gas

Some Call This a Gas Locked Pump

Stroke 190-314 SV Open

SV Stuck Open and TV Stays Closed.

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Pumping Gas Into Tubing, Then Light Gassy Gradient Unloads Tubing, No Pump Action as Rods Hanging in Tubing Filled With Gas.

Next 470 Strokes

Fluids in Tubing Flow Off

Pump Fillage 50%
Lots of Gas up Tubing
Gas Compression

Tubing Liquids Have Blown Out and Rod Buoyancy Missing
Missing Buoyancy

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Additional Tubing Backpressure Needed on this Well

1. Use of a tubing back-pressure regulating valve maintains pump action and prevents unloading of tubing liquids.

2. Back-pressure allows pump action to be maintained when differential pressure across plunger is low due to lightened tubing liquids from gas entering (pumped into) the tubing.

3. Surface tubing discharge pressure is higher when compared to the surface pressure if no backpressure regulating valve were present.

4. Additional tubing backpressure results:
   • Increased pressure at the pump discharge
   • Requires additional horsepower
   • Increased rod, unit, and motor loading
   • Potentially higher operating cost to pump the well
Use of Backpressure Regulating Valve on Tubing of a Sucker Rod Lifted Well

1. Previous Dynamometer Data Acquired Using a Calibrated Horseshoe Load Cell While the Tubing Discharge Pressure Was too Low

2. Backpressure can Prevent Tubing Fluids from Unloading
   - Unloading usually Caused by Poor Downhole Gas Separation with Gas Pumped into the Tubing
   - Tubing Fluids Lighten and Tubing Liquids Flow Off.

3. Best to Keep Gas Out of the Tubing by Setting the Pump Intake Below the Perforations

4. Or Use an Effective Downhole Gas Separator to Keep Gas Out of the Pump
Tubing Backpressure Impact on Pump with 50% Fillage

425 Psi Tubing Backpressure

PR HP = 3.3

PPRL = 12149 Lbs

SPM = 5.88

MPRL = 5936 Lbs

200 Psi Tubing Backpressure

PR HP = 2.9

PPRL = 11935 Lbs

SPM = 5.90

MPRL = 6639 Lbs
1. Backpressure regulating valve used to increase the tubing pressure.

2. Additional tubing backpressure results in increased pressure on the pump discharge and requires additional horsepower at the pump to lift the fluids to the surface.
Prevent Unloading Up The Tubing by Using a Backpressure Valve

Gas Flowing through Pump OR Pumped into Tubing

- Backpressure valve maintains high tubing pressure to prevent gas from blowing all of the liquid out of tubing
- Without BPV Pump action erratic & discharge may STOP

Increase Pressure by Compressing Spring

Pressure Gage

Flow

Spring Force

BPV

Harbison-Fischer Model Illustrated
Some Stuffing Boxes Can Increase Friction on Polished Rod

1. Tubing Backpressure Acting On Some Types Of Stuffing Boxes Can Result In Additional Friction Applied To the Polished Rod.

2. Pump Card Shows The Impact From The Additional Friction If Not Removed by Calculations at the Surface.

3. Extra Stuffing Box Friction:
   a) Increases Horse Power
   b) Increases Upstroke Loads
   c) Decreases Down Stroke Loads
1. Compare Back-pressure regulating valve used to increase the tubing pressure from 250 and 1000 Psig

2. Backpressure reduces the polished rod load (the polished rod load is reduced by a piston force equal to the back pressure times the area of the polished rod).

\[ \text{Piston Force} = \text{Back-pressure} \times \text{Area of Polished Rod} \]
Compare
250 to 1000 Psig Backpressure

<table>
<thead>
<tr>
<th>Backpressure</th>
<th>Load (Klbs)</th>
<th>Stroke Length (Inches)</th>
<th>Tubing Head Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 Psig</td>
<td>PPRL=12057</td>
<td>PPR=6568</td>
<td>227 BPD, 100 BOPD,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>300 MscfD</td>
</tr>
</tbody>
</table>
Use of Backpressure Regulating Valve on Tubing Results in

1. Increased the tubing fluid gradient
2. Increased the fluid load applied by the pump to the rods
3. Increased polished rod horsepower
4. Increased Rod loading with Higher Stress Range.
5. Increased the load on the prime mover
6. Reduced the plunger effective stroke length due to increased static stretch
7. Reduced in the pumping speed, due to motor slip
8. Reduced the effective pump displacement
9. Increased frictional forces the stuffing box applies to the polished rod.
Observations

1. Overall System Efficiency will be Less

2. Backpressure impacts measured surface loads

3. Sucker rod loading can be incorrect, because of the piston force, rod loading below the surface will be higher than measured

4. Use Backpressure ONLY IF a well is Flowing Off due to TOO Much Gas Produced Up the Tubing

5. If the tubing unloads and pump action stops, then try 200-300 Psi of backpressure on the tubing BUT use more if required by well
Benefits of Backpressure

1. Maintain Pump Action
2. Reduced Well Intervention by the Operator
3. Significantly Reduced Stuffing Box Leaks
5. Backpressure May Increases Operating Cost, But Allows You to Pump the Well
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