Comparing The Methods Of Controlling Liquid Loading

Jim Hacksma - Consultant
METHODS / SOLUTIONS COMPARED

- Choking
- Water Shut-Off
- Compression
- Velocity Strings
- Foam
- Plunger Lift
- Continuous Gas Circulation
- Continuous Gas Circulation + Compression
- Gas Lift
- Beam Pumping

POSSIBLE SOLUTIONS?
FOR LIQUID LOADING
CHOKING

- Smaller Choke
- Increased FTP (100# To 300#)
- Increased FBHP (bad)
- Increased Critical Rate (bad)
- Loading Even Worse (bad)
- DON’T INCREASE FTP
WATER SHUT-OFF (liquid elimination)

- Reduce Liquid From 200 To 1 Bbl/MMCF
- But, Liquid Loading Still A Problem
- Water Shut-Off Can’t Eliminate Loading
- Critical Rate Is Not Reduced

At Only 1 Bbl/MMCF, Loading Still A Problem
WATER SHUT-OFF (liquid elimination)

• A Seemingly Obvious Solution To Liquid Loading, But…
  – Can’t Eliminate All Liquid (4 sources of liquid)
  – Can’t Eliminate Loading (because some liquid remains)
  – Does Not Reduce The Critical Rate (Turner & Coleman)

• Often Accidentally Shut Off Some Gas
  – Makes Loading Even Worse

• The Benefits Are Questionable & Uncertain

• Before Undertaking A Water Shut-Off;
  – Must Be Certain Zone To Be Isolated Produces No Gas
  – The Water Producing Rate Must Be Extremely High
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COMPRESSION

- Install Compressor
- Decrease FTP (300# To 100#)
- Decrease FBHP (good)
- Decrease Critical Rate (good)
- **But, Loading Still A Problem**
- **NOT PERMANENT SOLUTION**

LOADING STILL A PROBLEM

CRITICAL RATES

300#

100#
COMPRESSION

• **Compression Good (reducing FTP), But Not For Loading**
• **Venting To Atmosphere Is Poor** (BP-Echometer Study)
• Then, **How Can Compression Be Good** (higher pressure)
• Personal Experience:
  – Installed Plunger Lift On Wells Already On Compression
  – Got Good Production Increases – Removed Compressors
  – Conclusion: *Compression Had Not Been Removing Liquid*
• **RECOMMENDATION:**
  – *First*, Install A Good Method For Controlling Loading
  – *Second*, Install Compression To Further Increase Production
VELOCITY STRINGS

NARROW OPERATING RANGE

- Lower Critical Rates
- **But**, Must Change Tubing Often
- BECOMES VERY COSTLY
- And, Loading Still A Problem

BROAD OPERATING RANGE

- 3/4”
- 1”
- 1 1/4”
- 2 3/8”
FOAM (a characterization)

- Used a Velocity String to Characterize
- Foam does help loaded wells
- But, loading is still a problem
- Not a permanent solution

Helps at lower rates (where loading is a problem)

Doesn’t help at higher rates (due to friction and/or density)
FOAM (a characterization)

• Foam Helps, But Not Enough
• No Rigorous Nodal Analysis, But What Do We Know?
  – Foam Gradient And/Or Friction Greater Than For Fine Mist
  – If Not, Foam Would Be Started At Higher Rates (above critical)
  – Critical Rate Reduced, But Not To “0” (loading still a problem)
  – In Between, *Foam Is Capable Of Helping Loaded Wells*
  – The Above Description Is *Similar To That For A Velocity String*
• The Prior Nodal Analysis Of Foam Is *Conceptually Correct*
• FOAM – *Loading Still A Problem - Not Permanent Solution*
PLUNGER LIFT – “GOOD WELL”

- Long Flows
- Short Shut-Ins
- FBHP Nearly As Low As Flowing Well

OPENING PRESSURE

“SHORT” SI

“LONG” FLOWS AT LOW FBHP

TIME-AVG FBHP RELATIVELY LOW
PLUNGER LIFT – “DEPLETING WELL”

- **Short Flows**
- **Long** Shut-Ins
- FBHP Much Higher Than Flowing Well

**OPENING PRESSURE**

**“LONG” SI**

**“SHORT” FLOWS AT LOW FBHP**

**TIME-AVG FBHP HIGHER**
PLUNGER LIFT (a characterization)

- Well Gets Weaker
- Flows Shorten & Shut-Ins Lengthen
- Time-Average FBHP Increases
- FBHP Increases, As With Liquid Loading
- Fewer Trips Can Be Made – Eventually None
- NOT A PERMANENT SOLUTION

An Improvement, But Not Perfect

FBHP & Back-Pressure Increase As Well Gets Weaker
PLUNGER LIFT

- Most Common Solution For Liquid Loading
  - As Good As Plunger Lift Is, It Is Not Perfect (may not be best)
- Prior Nodal Not Rigorous, But Conceptually Correct
- As Well Declines;
  - SI Periods Grow Longer & Flow Periods Grow Shorter
  - **WHILE** Reservoir Pressure (SBHP) Is Decreasing….
  - Back-Pressure (FBHP) On Formation Is Increasing
  - A BAD COMBINATION
  - *Very Similar To Loading* (decreasing SBHP & increasing FBHP)
  - Eventually, *Well Quits Producing Because It Can No Longer Build Up To The Opening Pressure Of The Plunger*
CGC (continuous gas circulation)

- CIRCULATION MAINTAINS LOW FBHP;
- CONTINUOUSLY
- DOWN TO “0” RATE
- PERMANENT SOLUTION

CGC MAINTAINS LOW FBHP, DOWN TO “0” RATE, PREVENTS Loading PERMANENTLY
CGC (continuous gas circulation)

Note Compressor Position:
• Sales By-Pass Compressor
• Does Not Reduce FTP

Think Of CGC As Gas Lift, Except:
• No Gas Lift Valves
• No Packer
• No Outside Source Of Gas

Formation Gas = Sales Gas
Circulated Gas
Formation + Circulation = High Velocity

Separator → Compressor → Motor Valve → Sales Meter → Sales Meter
Formation Gas = Sales Gas
Circulated Gas
Formation + Circulation = High Velocity

See Presentation On CGC At This Workshop
SAME RATE UP TUBING – SAME FBHP

Before Loading

Separator

Same FTP

Same Rate

Same FBHP

CGC Achieves Same FBHP That Existed Before Loading

After Loading w/ CGC

Separator

Compressor

See Presentation On CGC At This Workshop
CGC + COMPRESSION

- Use One Compressor To Both Reduce FTP & Circulate
- Compression Is Good, But Not For Controlling Loading
- Circulation Controls Loading
- In Tight Reservoirs, Little Sales Increase Over CGC Alone

Critical Rate

300#
100#

Prevents loading permanently
CGC + COMPRESSION

Advantage Of Both CGC (controlling loading) & Compression (reducing FTP):
- Increased Production

Disadvantages:
- Added Controls & Metering
- Added Operating Complexity
- Compression Ratio & HP Increased
- Little Production Increase Over Simple CGC
  - Especially In Tight Reservoirs

See Presentation On CGC At This Workshop
GAS LIFT

- If Done CORRECTLY, Gas Lift Is As Effective As CGC
- Plus, Offers Some Advantages Over CGC
- A PERMANENT SOLUTION

LOADING

MAINTAINS LOW FBHP, DOWN TO “0” RATE, PREVENTS LOADING PERMANENTLY
Done Correctly, Gas Lift Can Be Very Good
- Classic Design For Oil Wells Not Best For Gas Wells

Gas Lift Used To Recover Frac Fluid
- Or, If A Shut-In Won’t Create Dry Wellbore

CGC Used To Control Liquid Loading

Transition From Gas Lift To CGC
- Unload With Gas Lift Valves & Buy-Back Gas
- Transition To CGC
- Circulate Around End-of-Tubing & Quit Buying Gas
- Reduce Discharge Pressure, Ratio & HP

See Presentation On CGC At This Workshop
### BEAM PUMP (gas locking example)

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<th><strong>WELL PRODUCTION</strong></th>
<th><strong>PUMP CAPACITY</strong></th>
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<tr>
<td>Gas Well With Loading</td>
<td>1-1/4” Pump - 64” Stroke</td>
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<tr>
<td>100 MCFD</td>
<td>8 SPM - 11,520 Strokes / Day</td>
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<tr>
<td>10 Bbl / MMCF</td>
<td>1.23 In^3 / Inch Of Stroke</td>
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<tr>
<td><strong>1 BPD</strong></td>
<td>Only 0.7” Of Liquid Fill / Stroke</td>
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<tr>
<td>42 Gal / Day</td>
<td>Virtually No Liquid Entering Pump</td>
</tr>
<tr>
<td>5376 Ounces / Day</td>
<td><strong>No Pump-Off Controller</strong></td>
</tr>
<tr>
<td>Only 0.47 Oz Per Stroke</td>
<td>Gas Enters Pump</td>
</tr>
<tr>
<td>Only 0.85 In^3 Per Stroke</td>
<td>Pump Is Poor Gas Compressor</td>
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<tr>
<td>Liquid Builds Up In Casing</td>
<td><strong>PUMP “GAS LOCKS”</strong></td>
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<tr>
<td><strong>Production Decreases</strong></td>
<td>Pump Moves No Liquid Nor Gas</td>
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BEAM PUMP

- Most Common – It Is The Best For Many Wells
- But, **May Not Be Best Where Liquid Volume Is Low**
- Gas Separation Can’t Prevent Gas From Entering Pump
- **Pump-Off Controller Is A Must**
  - Even With A Pump-Off Controller, A Pump May Not Be Best
- **Personal Experience:**
  - On Oil Wells With Increasing GOR, Replaced Pumps With PL
  - Got Production Increases – *Plunger Lift Was Better Than Pump*
- **Conclusion:** **Pump Is Not Always Best**
### A QUICK REVIEW

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<td>Gas Lift</td>
<td>Can Be As Good As CGC + Advantages</td>
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<td>Beam Pumping</td>
<td>Not Best Where Liquid Rate Is Low</td>
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THANK YOU

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