Two Short Topics

1) Using Compressors More Effectively

2) Improving Upon Poor-Boy Gas-Lift

Jim Hacksma – Consultant
1) Using Compressors More Effectively
Loaded Wells & Compressors Don’t Work Together Very Well

- When Working With Compressors & Loaded Wells, There Has Been **Only One Thought**:
  - Create Lower Lower Lower Lower FTP ➤ But, Has Not Always Worked
  - Often Well Remains Below Critical ➤ Should Not Be Surprising
  - Some Wells Will Not Unload Even To Atmosphere (zero psi)
  - Then, **Why Would Those Same Wells Unload With A Compressor?**

- What Happens With Compressors & Loaded Wells?
  - Production From Loaded Well Is **Erratic** ➤ Sometimes **Almost Zero**
  - Compressor **Often Quits** ➤ Starved For Gas ➤ Low Suction Pressure
  - Excessive Compressor **Downtime** ➤ **Poor Production**

- **What Can Be Done?** ➤ Lets Look At **One Example**
LOADED WELL & COMPRESSOR

- MCFD
- CP
- FTP

**On Compression**
- Erratic Rate & Pressures
- Excessive Downtime

Compressor can draw down FTP & Ps to 120. But, well is below critical, is erratic, often near zero, compressor often quits. Thus, typical FTP = 500-1100 & CP = 800-1500.

Well Is Already On Compression.

What Further Can Be Done To Increase Production?
"SAME" COMPRESSOR - DIFFERENT RESULT

On Compression
- Erratic Rate & Pressures
- Excessive Downtime

Same Compressor w/ INJ
- No Longer Erratic
- Reduced Pressures
- Increased Gas Sales

Compressor can draw down FTP & Ps to 120. But, well is below critical, is erratic, often near zero, compressor often quits. Thus, typical FTP = 500-1100 & CP = 800-1500.

Instead, chose to operate with FTP & Ps = 300 & inject some gas down casing. Now little down-time. Now FTP = 300 & CP = 550 + production increased.
An Example Why: Lowest FTP Not Always Best

- Lower FTP
- No Injection
- Below Critical
- Heavy Gradient
- High FBHP
- Poor Production

- Higher FTP
- With Injection
- Above Critical
- Lighter Gradient
- Lower FBHP
- GREATER PRODUCTION
Formation Gas = Sales Gas

Injected Gas

- Formation + Injection = High Velocity In Tbg
- Above Critical ➤ No Longer Erratic
- Ample Gas To Compressor Suction
- Compressor No Longer Quits
- Increases Production
To Succeed, **Must** Follow Procedure

When Starting for the Very First Time

1. **SI** ► **Build Pressure** ► **Force Liquid Back Into Formation** ► **Create Dry Wellbore**
   - **Works In “Most” Gas Wells** ► **Not Intended For Oil Wells**

2. **Start Moving Gas Thru Wellbore While ** **Still Shut-In**
   - Create Critical Rate With Compressor Only
   - High SITP = High Critical Rate
   - But, High Ps Allows Compressor To Move Needed Rate

3. **Start Sales** ► **Slowly Increase Sales**
What Is Done?

- **Use Same Compressor ► Use It Differently**
  - Increase Compressor Capacity ► **Capacity Is Not Fixed**
  - Higher Ps & Lower Compression Ratio
  - Cripple Cylinders ► Remove Valves ► 3→2 Stage or 2→1 Stage
  - **Permits Moving More Gas** (and still have adequate HP)
  - Can Be Done With “**Most**” Compressors

- **Inject “Some” Of Compressor Discharge Down Casing**
  - Enough To Remain Above Critical In Tubing

- **The Benefits**
  - Increased Tubing Flow ► Above Critical ► Liquids Carried Out
  - Lighter Gradient ► FBHP & CP Reduced ► **Increased Production**
  - Well No Longer Erratic ► **Little Compressor Downtime**
Which Is More Important? Low Pressure **OR** High Velocity?

- **Low Tubing Pressure** (no matter how low) Is Often Unable To Keep A Well Unloaded ➤ The Results Are:
  - Low Tubing Velocity ➤ Heavy Flowing Gradient ➤ High Flowing Bottom Hole Pressure ➤ *Poor Production*

- However, **High Tubing Velocity** Can Often Provide:
  - Lighter Flowing Gradient ➤ Lower Flowing Bottom Hole Pressure ➤ *Higher Producing Rates*

- Instead Of Simply Creating *Lower Lower Lower Lower Lower FTP*

- **Use Your Compressor Differently** ➤ Move Gas Thru The Wellbore & Create High Tubing Velocity
2) Improving Upon Poor-Boy Gas-Lift
Poor-Boy Gas-Lift (PBGL)

- Limitations Of PBGL
  - Can’t Lift Large Columns / Slugs Of Liquid ➤ No GL Valves
  - Need Outside Source Of Gas
  - Because Of Above Limitations, PBGL Has Only Limited Application

- What If Those Limitations Could Be Overcome, Cheaply
  - SI For Extended Time ➤ Build Pressure ➤ Force Liquid Back Into Formation ➤ Create Dry Wellbore ➤ No Liquid ➤ Only Gas
  - With No Liquid In Wellbore & Still SI, Can Easily Pull Gas From Tubing & Inject Back Into Casing ➤ Move Gas Thru SI Wellbore
  - No Need For Outside Source ➤ Ample Gas Stored In Wellbore
  - Compressor Won’t Go Down On Low Suction
  - Create Critical Rate (w/ Compressor) While Still SI ➤ Before 1st Prod
Gradient Of Flowing “Loaded” Well

1. Too Much Liquid?
2. PBGL May Not Work?
Gradient Of Same Well “After SI”

- After Shut-In
- No Liquid In Well
- No Need For GL Valves
- And, No Need For Outside Gas
  - Ample Gas Stored In Wellbore
  - Easy To Pull Gas From Tubing
  - And, Inject Gas Into Casing
  - Easy To Move Gas Thru Wellbore
Slowly Reduce Pressure & Slowly Increase Producing Rate

- Create Critical Rate
  - While Still Shut In
  - Before Producing
- Slowly Reduce Pressure
  - Slowly Increase Sales
  - Slowly Increase Liquids
- Always Above Critical
- Soon Well Is Full Open
- But, No More Loading
Formation Gas = Sales Gas

Injected Gas

- Formation + Injection = **Above Critical in Tbg**
  - Start With Dry Wellbore ➤ No Outside Gas Required
  - A **Different** Compressor Location
  - **Sole Purpose** Of Compressor Is To Move Gas Thru The Wellbore & **Create High Velocity**
  - Sales By-Pass Compressor ➤ Can’t Reduce FTP
To Succeed, **Must** Follow Procedure

**When Starting for the Very First Time**

1. **SI** ► **Build Pressure** ► **Force Liquid Back Into Formation** ► **Create Dry Wellbore**
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3. **Start Sales** ► **Slowly Increase Sales**
“Improved” Poor-Boy Gas-Lift (PBGL)

- **Great Things Are Possible**, Once You Create A Dry Wellbore
  - The Result Of An Extended Shut In ➤ Works In “Most” Gas Wells

- **Previous Limitations** OF PBGL **Can Now Be Overcome**
  - Liquid Columns No Longer A Problem ➤ Forced Into Formation
  - Outside Source Of Gas No Longer Needed
    - Ample Gas Stored In Wellbore
    - Without Liquid In Wellbore, It Is Easy To Move The Stored Gas
    - Move Stored Gas As Fast As One Desires (i.e.; Above Critical)
    - Begin Sales **After** Critical Rates Have Been Created w/ Compressor

- **“Improved” PBGL Can Be Used To:**
  - Unload A Well ➤ Keep It Unloaded ➤ **INCREASE PRODUCTION**

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Introducing “CGC”

*Continuous Gas Circulation*

(may be new to some of you)
Continuous Gas Circulation (CGC)

- "CGC" Is The Technology Behind:
  - "Using Compressors More Effectively"
  - "Improving Upon Poor-Boy Gas Lift"
- Relatively New ► I Began Developing CGC In 1996
- Great Things Are Possible Once You Create A Dry Wellbore
  - CGC Takes Advantage Of That Fact
  - 1st, Well Is Shut In ► Until Dry Wellbore Is Created
  - 2nd, Critical Rate Created w/ Compressor ► “Before” Sales Started
  - No Outside Gas Required ► No Gas-Lift Valves Required
  - ONLY "CGC" Can Simultaneously:
    ✓ Reduce FTP (conventional compression) & Control Loading (circulation)
Conclusions Regarding “CGC”

- If Creating **Lower Lower Lower Lower FTP** Is The Only Thing You Do With Compressors, You Are **Missing Opportunities**

- “Continuous Gas Circulation” Is **A Better Way**
  - Data Shown Earlier Is Convincing ➤ **Circulating Gas Works**
    - Used “Existing” Compressor Differently To Increase Capacity
    - Used Increased Capacity To Circulate Gas Thru Wellbore
    - Increased Production

- “CGC” Is **A Permanent Solution** For Liquid Loading
  - Few Other Methods Are Permanent Solutions

- Use “CGC” As An Alternative To:
  - Velocity Strings ➤ Conventional Compression ➤ Foam ➤ Pump ➤ Plunger Lift ➤ Gas-Lift ➤ Etc.
Some **BOLD** Statements

**What Should You Expect From CGC?**

- **CGC Often Yields Higher Gas Rates**
  - As Much, or More, Than Other Methods Of Artificial Lift
    - In Early Stages Of Loading (at higher rates), CGC Has Little Advantage
    - In Later Stages (continued decline), CGC Has **Greater** Advantage

- **Longer Life & Higher Ultimate Recovery**
  - Should **Recover More Gas** Than Other Methods
  - When Other Methods Quit, CGC Can Return Your Well To Production
    - 1\(^{st}\) Installing Another Method ➤ 2\(^{nd}\) Installing CGC ➤ Is **Expensive**
    - Installing CGC As Initial & Final Solution For Loading ➤ Is **Cheaper**
  - Shut-In Wells Can Be Good Candidates For CGC
Questions?

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