Continuous Gas Circulation;
A New Artificial Lift Method

Jim Hacksma - Consultant
CGC (continuous gas circulation)

- **Not Really New.** Something Similar To CGC Has Been Around Since Early 1960’s, or earlier.
- But It **Never Worked Well**
- Have Developed **A Better Way**
- Wrote First Paper On CGC In 1997 (SPE #37426)
- **CGC Will Probably Be New To You**
- What Is Clearly New Is **Growing Evidence That CGC Is Effective** In Controlling Liquid Loading
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

Separator ➔ Motor Valve ➔ Sales Meter

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

• Use To Control Liquid Loading In **Gas Wells**
  – *Where Liquid Volume Is Usually Modest*
  – Not For Use In Oil Wells Or Water Wells

• Use CGC As An **Alternative To:**
  – Velocity Strings
  – Compression
  – Foamers
  – Pumping
  – Plunger Lift
  – Gas Lift
  – Etc
• Well Capable Of Only 100 MCFD Sales
• Critical Rate Is 500 MCFD (loading problem)
• Design Compressor To Circulate 500 MCFD
• Total Flow Up Tubing Is 600 MCFD
• Now Above Critical – Carries Out Liquids
• If Sales Decline To “0”, Still Carries Liquids
• Thus, A Permanent Solution
Because Sales By-Pass Compressor & FTP Is Not Reduced

- **If There Is NO Motor Valve**
  - If Compressor Quits, **Well Continues Flowing** At Low Rate
  - Liquid Loading Begins (again)
  - Creates Liquid Column – “Cannot” Resume Circulating

- **But, WITH Motor Valve** (tied to compressor)
  - If Compressor Quits, Motor Valve Is Closed & **Well Is SI**
  - Liquid Loading Is Prevented From Beginning
    - **NOTE:** Loading Occurs While Flowing – Not SI
  - No Liquid Column Created - “Can” Resume Circulating
CGC IS “COUNTER-INTUITIVE”

Reasons Why People Think CGC Can’t Work:

• Can’t Circulate
  – Or, Can’t Circulate & Sell
  – Need Gas Lift Valves

• Injecting Places Back-Pressure On Formation
  – Or, Gas Will Enter The Formation
  – Need A Packer

• Need An Outside Source Of Gas

• On The Contrary, CGC:
  – Is A Direct Solution To The Problem (Increases Velocity)
  – Should Be An Obvious Solution
ABILITY TO CIRCULATE?

• With A Tall Liquid Column, You Can’t Circulate

• “However”, (1) **Shut In** Most Gas Wells, Then;
  – Liquid Is Forced Back Into Formation
  – A Dry Wellbore Is Created

• (2) **Begin Circulating** Thru “Dry” Shut-In Well

• (3) **Begin Sales** – Liquid Entering Well Is Carried Out By Circulating Gas
  – OR, If SI Pressure Is Too High For Separator Or Compressor;
    • 1) SI To Create Dry Well, 2) Sell To Decrease Pressure, 3) Circulate

**NOTE:** *No Outside Gas Was Needed*
CIRCULATION

If a container (or wellbore) is **dry**, a simple box fan can put gas in motion (i.e., circulate)

- Change shape (any closed loop)
- Change shape to look like well
- Increase pressure
- Replace air with gas
- Add entry port (perfs)
- Add exit port (sales meter)
- *End up with schematic of CGC*
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
CGC LOWERS THE CP (not increase)
OUTFLOW OF “FLOWING WELL”

CGC RE-CREATES THE LOWEST FBHP; THAT WHICH EXISTED PRIOR TO LOADING

INCREASE DUE TO LOADING

CRITICAL RATE

INCREASE DUE TO FRICTION
OUTFLOW OF “CGC”

CGC MAINTAINS LOWEST FBHP, PREVENTING LIQUID LOADING

THE LOWEST FBHP;
• CONTINUOUSLY
• DOWN TO “0” RATE

LOADING

FRICTION

CRITICAL RATE

Flowing Sandface Pressure, psig

0 100 200 300 400 500 600 700 800 900 1000

Gas Rate, MMScf/d

0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00
FACTS & INFO

• CP-TP and DP-SP Both Small
• Thus, Low Compression Ratio & Low HP
• No Controls – No Control Problems
  – No Split Of Discharge Between Sales & Circulation
  – Compressor Cylinder Is The Controller
• **Increasing Line Pressure Not A Problem**
  – If LP Increases, SP Increases
  – Is SP Increases, Circulation Increases
  – *Well More Resistant To Loading*
  – **THAT IS GOOD**
FACTS & INFO (cont’d)

• With Conventional Compression;
  – Compressor Design Depends Upon Well’s PI
  – Thus, Each Well Has Different Compressor Design

• With CGC, “Cookie Cutter” Compressor Design
  – Compressor Design Depends Upon “LP & Tubing”
  – Most Wells In Area Have Similar LP & Same Tubing
  – Thus, All Wells Have Same Compressor Design

• No After-Cooler Needed (saves money)
  – Hot Discharge Gas Circulates Thru Well, And Cools, Before Going To Sales
WHAT CGC IS NOT & CAN’T DO

• **Can’t Lift Large Volumes** of Liquid
  – CGC Used To Lift Modest Volumes Of Liquid From Gas Wells
  – Volumes Typically Found In Gas Wells With Liquid Loading

• **Can’t Remove Tall Columns** Of Liquid
  – CGC Can’t Create High Pressure (And Does Not Need To)

• **With CGC, Well Must First Be Unloaded By Another Means**
  – SI, Build Pressure, Force Liquids Into Formation, Flow To Unload
  – CGC Then **Prevents Future Liquid Loading**
  – **Same Is True Of Plunger Lift, Velocity Strings, Foam, Compression**
    (If The Well Is Loaded When The System Is Installed, The Well May First Require Unloading In The Above Described Manner)
COMPARISONS

• CGC Allows Use Of Standard Size Tubing
  – Unlike Velocity & Capillary Strings
  – Permits Swabbing & Slickline Tools

• Works With Tubing Restrictions Or Sand
  – Unlike Plunger Lift

• **Continuously** Maintains A Low FBHP
  – Unlike Plunger Lift

• No Outside Source Of Gas Required
  – Unlike Conventional Gas Lift
COMPARISONS (cont’d)

• No Gas Lift Valves Required
  – Unlike Conventional Gas Lift

• No Downhole Equipment Required
  – Unlike Most Other Methods

• No Gas Locking Or Gas Interference
  – Unlike Pumps

• Increases In Line Pressure Pose No Problem
  – Unlike Most Other Methods

• Can Be Run In Horizontal Section Of Horizontal Wells
  – Unlike Plunger Lift
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**AVG 45 MCFD INCREASE**

**75% SUCCESS**

- **Typical Well:** 7000’ - 2¾” Tubing - 5½” Casing – 300# LP
- **Typical Liquid:** 15 Bbl/MMCF (0.25 – 1000+) & 100% Water
- **MOST WELLS PREVIOUSLY ON FOAM, PLUNGER LIFT, OR BOTH**
## NORTH TEXAS (low pressure)

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**DID NOT WORK – COULD NOT CIRCULATE**

**BHP TOO LOW (<100#) FOR CGC??**

**OTHER METHODS NOT WORKING EITHER**
NW LOUISIANA (single well)

• Before
  – **Well SI** Due To Liquid Loading
  – LP = 1000 psi
  – 2-Stage Compressor – Could Pull **FTP Below 75#**

• After
  – **Existing Compressor** Converted To 1-Stage
  – Configured To Both Circulate & Reduce FTP
  – **FTP = 400#** & **CP = 575#**
  – Circulate 300 MCFD
  – **Sell 250 MCFD** - **250 GAIN**
  – 550 MCFD Up Tubing

**MORAL:** High Velocity More Important Than Low FTP

**Low Cost**
VARIATION #1 – CGC + REDUCE FTP

- Advantage Of Both CGC (controlling loading) & 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

Used On Louisiana Well
VARIATION #2 – CGC + GAS LIFT

- **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 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
COMMENTS ABOUT CGC

• Still In Its Infancy - Received Minimal Exposure
• Has Not *Yet* Gained Wide Acceptance

• **The Science Is Sound - CGC Does Work**
  – Barnett Shale Results (compared to foam & PL)
    • *75% SUCCESS RATE & AVG 45 MCFD GAIN*
  – Did Not Work In Low BHP (nor did other methods)
  – 250 MCFD Gain In Louisiana Well

• Already Very Good. With More Use CGC Will *Get Even Better*
WHICH METHOD IS BEST?

• How Do These Methods Compare?
  – Plunger Lift
  – Velocity Strings
  – Foam
  – Compression
  – Continuous Gas Circulation
  – Gas Lift
  – Beam Pumps

• Come See My Other Presentation
  – “Comparing The Methods Of Controlling Liquid Loading”
  – Tomorrow – Last Presentation Of The Day
THANK YOU

Jim Hacksma - Consultant
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