New Life for Old Wells: Finding Production and Economic Wins in Gas Wells with Tubing Perforation and Plunger Lift

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The Grande Picture

As many as 10% of Laramie Energy’s Piceance Basin tight gas wells were non-productive or under-performing due to deep-set tubing or mechanical restrictions in tubing or casing.

A program of evaluating existing completions, prioritizing candidates, perforating and/or cutting tubing, and reestablishing plunger lift has been undertaken.

In addition to increasing gas production, benefits include reducing regulatory load, man hours, operating expense, and environmental impacts.

To date, 36 jobs on 33 wells have been completed with 3 wells still in progress, 1 failure, and 1 well that developed a HIT after the job for an 85% success rate that could climb to 94%.
The Process: What Are We Doing?

1. Identify candidates through routine surveillance, well reviews, or identification by operators, foremen, analysts, or anyone!
2. Determine upside based on production history, decline curve analysis, offset wells, analogs, etc.
3. Vet candidates with thorough top-down trouble shooting, shooting fluid levels, testing casing flow, running slickline, etc.
4. Determine non- or under-performance mechanism.
5. Draft procedure to cut and/or perforate tubing at specified depth, install downhole equipment, and drop a plunger.
6. Do it! Do it! Come on! Do it now!
Candidate Selection: What kind of wells are we looking for?

- Tubing perforation candidate characteristics:
  - Cycle on and off due to loading
  - Will not run a plunger
  - Require frequent swabbing
  - Require chemical assistance such as foaming agents
  - Sensitivity to line pressure fluctuations
  - Have known mechanical issues (sanded tubing or plugged tail)

- Candidate prioritization; the best candidates have:
  1. Recent production
  2. Sufficient pressure
  3. Lower liquid ratios

Lean on geo and reservoir folks for insight and input!
Implementation: Yes, it is this simple.

► General approach for perforating tubing:
  ► Immediately above known restrictions or problems.
  ► Deeper in wells with recent production and higher pressures.
  ► Higher in older, wetter, lower pressure wells with unknowns.

► Procedure:
1. Retrieve plungers and equipment and/or cut off tubing tail
2. Perforate or cut tail at pre-determined depth
3. Set tubing or collar stop
4. Land bumper spring on stop
5. Drop plunger
6. Stick with it!
Wellbore Diagram and Procedure:

Recommendations:
1. Perforate enough holes for sufficient inflow.
2. If sanding is a potential problem:
   a) Consider a rathole if tail not clear.
   b) Consider setting the stop higher.
3. Tubing stops > collar stops.
4. Use wireline for better depth control and more robust fishing ability.
5. Execute all steps at once.
Case Study, Eh (the First)

2010 vintage, reported 514 BBLs/MMCF
► Shut-in Q3 2019 due to low gas prices
► Compression removed
► RTP December 2019
► Loaded up March 2020
► Swabbed on April 2020
► Loaded up April 2020
► Initial tubing perforation job on 05/20/20 moved effective tail up 342’ (92% to 76%) and was unsuccessful
► Second tubing perforation on 12/08/2020 moved effective tail up another 1549’ (to 0%) and was successful
Case Study, Eh (the First)
Case Study Beto

So, when did we do it?
Case Study Orbison

2010 vintage, reported 153 BBLs/MMCF

► Loading problems began 2016
► No production for 7 months of 2020
► Upper zones are basin bread and butter, lower zones are better sands → deplete faster → suspected tubing swamped
► Perforated tubing 50% into upper zone perforations, 506’ below top completion perforations
Case Study Scalia

Well Scalia

Well #15
Job #18

Gas (MCFD)  Fit (MCFD)  Casing (psi)  Line (psi)
Case Study JFK Jr.

2010 vintage, reported “wet”
► The dog days began on day 1 and are not over
► Cumulative production of 364 MMCF, roughly 25% of an average well
► Water production known to be high but not quantified
► Perforated tubing 550’ below top completion perforation, unsuccessful
► Post-job water yield = 1 BBL / MCF
► Remaining options are pumping a foaming agent, swabbing, reperforating, and pumping cement
Case Study JFK Jr.

Well JFK Jr.

Well #23
Job #26

- Gas (MCFD)
- Flow (MCFD)
- Casing (psi)
- Line (psi)
Case Study Vega

2008 vintage, perforations 6928’-8460’, tubing tail @ 7591’
► Fell off trend in 2012, subpar well, production ceased in October 2021
► Slickline verified sand @ 7535’ on 11/16/2021
► Jet cut tubing tail @ 7478’ and set tubing stop on 12/08/2021
► Well flowed for several days, and plunger running since
► Results far exceeding projections
Case Study Vega
<table>
<thead>
<tr>
<th>Job #</th>
<th>Well Alias</th>
<th>Initial Problem</th>
<th>Formations</th>
<th>IP Date (yyyy.mm)</th>
<th>Top Perf (ft)</th>
<th>Btm Perf (ft)</th>
<th>Tbg Tail (ft)</th>
<th>Tbg Into Perfs (%)</th>
<th>Tbg Past Top Perf (ft)</th>
<th>LGR (BBLs/MMCF)</th>
<th>Top Tbg Perf / Cut (ft)</th>
<th>Tbg Into Perfs (%)</th>
<th>Tbg Past Top Perf (ft)</th>
<th>Incremental Rate (MCFD)</th>
<th>Do It Again?</th>
<th>Lookback Notes</th>
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<td>2008.03</td>
<td>6928</td>
<td>8460</td>
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<td>43.3%</td>
<td>663</td>
<td>7478</td>
<td>36%</td>
<td>550</td>
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<td>great</td>
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<td>4260</td>
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Evolution, so far …
Economic Impact:

Results of the first 32 jobs on 29 wells:

► Production: Average 100 MCFD / well 90d incremental gain & 2021 exit rate of 3.5 MMCFD

► Reserves: Total addition of 3.2 BCFE or 110 MMCFE/well

► Cost: $210,000 or $7,240 / well

► Value (PV10%): $5,074,000 or $175,000 / well
Summary, Findings, and Lessons Learned

► Developed a repeatable process to identify and prioritize candidates, perforate and/or cut tubing, and reestablish plunger lift to restore new life to old wells.
  ► Acquire as much good data as reasonably possible.
  ► Aim to understand well history, completions, geology, what is happening in the reservoir(s), in the well, and at surface, and ultimately the failure mechanism.
  ► Determine upside with DCA and comparison to offsets and analogs.
  ► Learn from failures, perform periodic lookbacks, and evolve.
  ► **Focus on good decision making and be persistent.**

► This approach is low cost, low risk, and high reward.

► Benefits include reducing regulatory load, man hours, operating expense, and environmental impacts (e.g., reduction or elimination of venting).

► General approach for perforating (and cutting) tubing:
  ► Immediately above known restrictions or problems.
  ► Deeper in wells with recent production and higher pressures.
  ► Higher in older, wetter, lower pressure wells with unknowns.
Acknowledgements/Thanks & Questions

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Thanks to Laramie Energy for allowing use of the data.
Thanks to ERCOT for bailing us out 2021-February with $170 spot prices!
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