Smart Intermittent

or

Go with the Flow (and no artificial lift)

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Thought Experiment

• What is the biggest enemy of gas well production?

Liquid Loading

• How could we prevent this enemy from affecting the well in the most basic way possible?

Don’t Let Liquid Loading Happen

• What would we need to provide this prevention?

Never Flow Well Below Critical Velocity (Rate)
Thought Experiment (Continued)

• **How can we “Never Flow Well Below Critical Velocity (Rate)”?**

  Know What Critical Velocity is and SHUT WELL IN BEFORE IT OCCURS

• **What Devices Would be Required to Do This?**

  One Intelligent Device monitoring velocity vs critical velocity and telling One Valve to Shut (and then open) the Well to prevent liquid loading
What is a Smart Intermitter?

• **Smart** - showing intelligence or good judgment (*Merriam Webster Meaning 2*)

• **Intermit(ter)** - to cause to cease for a time or at intervals (*Merriam Webster*)

One Intelligent Device monitoring velocity vs critical velocity and telling One Valve to Shut (and then open) the Well to prevent liquid loading
How would device know the well is reaching Critical Velocity?

Calculate Coleman Critical Velocity (Rate) -2 7/8” =350 MCFD @ 50 psig
## Calculated Critical Rate (Coleman), MMCFD

<table>
<thead>
<tr>
<th>Tubing</th>
<th>Casing</th>
<th>Flow Path</th>
<th>Surface Pressure, psig</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 7/8&quot;, 6.5#/ft.</td>
<td>7&quot;, 23#/ft.</td>
<td>tubing</td>
<td>200 0.6 100 0.46 50 0.35 20 0.25 2 0.18</td>
</tr>
<tr>
<td>2 7/8&quot;, 6.5#/ft.</td>
<td>7&quot;, 23#/ft.</td>
<td>annulus</td>
<td>3.4 2.5 1.9 1.4 0.95</td>
</tr>
<tr>
<td>3 1/2&quot;, 9.3#/ft.</td>
<td>7&quot;, 23#/ft.</td>
<td>tubing</td>
<td>1 0.7 0.52 0.38 0.26</td>
</tr>
<tr>
<td>3 1/2&quot;, 9.3#/ft.</td>
<td>7&quot;, 23#/ft.</td>
<td>annulus</td>
<td>3 2.2 1.6 1.2 0.83</td>
</tr>
</tbody>
</table>

Just Calculate Critical Rate Using Flow Path Size and Pressure, etc.
Per Coleman...

**BUT IS THIS ALWAYS RIGHT?**
Other ways to know the well is reaching Critical Velocity?

- Gas and Liquid Rate Drops?
- Casing Pressure Increases?
- Calculate Coleman Critical Velocity (Rate) -2 7/8” =350 MCFD @ 50 psig
- Liquid No Longer Lifted?
Compensation for Wellhead Pressure Needed?

Downstream Production Separator Pressure Variation Over Time
Is Rate the Only Criteria to Use?

Coleman Critical Velocity (Rate) - 2 7/8” = 350 MCFD @ 50 psig

Gas and Liquid Rate Drops?

Casing Pressure Increases?

Liquid No Longer Lifted?
Casing Pressure Increases when gas and water rates are decreasing. Well has reached critical velocity.

Rate is 700 MCFD @ 33 psig
Critical Rate, Coleman is 440 MCFD So Calc. Low by 60%
\( \frac{700}{440} = 1.6 \)

Dead Band or failure to refresh SCADA on Casing, Water and Gas.
Rapid Drop in gas and water rate may indicate well has reached critical rate.

Critical Rate is 960 MCFD, Calc. (Coleman)is 1500 MCFD up the 3.5” x 7” annulus so correction factor is .65
Why Not Discontinue Critical Rate Calcs and Use Empirical Indications ONLY?

- Concept is useful for correcting for pressure variations, etc.

- Serves as a threshold to tell operator to start monitoring more closely or to prevent severe liquid loading

- Because someday we might get a very accurate calculation covering all conditions and configurations
What device calculates critical rate at pressure/ uses empirical methods?

- Most Latest Generation Plunger Lift Controllers

- Smart Intermitting is like good plunger lift operation *without the need to create a slug*
When do you open the well?

- Enough pressure to ensure time for liquids to get to surface in next flow period
- Need to be careful about effects on the rest of the system when opening
- Optimum cycle is to flow to just before critical rate and open as soon as possible
Advantages of Smart Intermitters

• Cheap to Install and Operate

• Uses same concepts as plunger lift and easily upgradeable to plunger lift

• Works on any well, including where wellbore mechanical problems prevent other artificial lift methods

• Protects against big pressure swings in system
Disadvantages of Smart Intermitters

- Cheap but *Not Free* to Install and Operate
  - Requires knowledgeable operator to optimize

- Causes some liquids to be pushed back in reservoir with each cycle

- Inferior to well implemented artificial lift

- Causes well “downtime”
Can Smart Intermittent be Done Manually?

- Yes, requires planning on logistics
- Does not compensate for pressure changes
- Almost never results in “optimum cycle”
Summary of Results of 300 Smart Intermitter Installations Over 6 Years

- Average uplift of 21% over predicted decline (Average Rate of Wells 300 MCFD)

- Better wells had higher % uplift

- Uplift could have been more with better optimization using empirical loading correction
Why Aren’t Smart Intermitters Used More?

• Not understood well or discussed much
  – Exception Steve Coleman’s Papers

• Little documentation available on rate and reserves increases possible

• Failure to Straightforward Apply Empirical Analysis

• Too cheap and easy
Acknowledgement and Path Forward

• Steve Coleman’s Papers on Gas Well Load-Up SPE 20820-23 especially on blowdown

• In the future I hope to communicate/present more to follow up on Steve’s work and the practical application/results of Smart Intermitting
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