Restimulation: Candidate Selection Methodologies and Treatment Optimization*

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Abstract

Restimulation of existing wells represents a vast underexploited resource. A successful refracturing treatment is one that creates a fracture having higher fracture conductivity and/or penetrating an area of higher pore pressure than the previous fracture. Refracturing requirements are different in highly permeable formations (high fracture conductivity) as compared to low permeable ones (moderate fracture conductivity). Understanding these basic differences is essential to a successful restimulation.

In the past, candidate selection methodology has focused on underperforming wells. This simplistic approach has yielded disappointing results and has led to a common misconception that restimulations “don’t work.” Production statistics of a well alone may not offer an effective methodology for selection of a restimulation candidate. Other parameters such as high BHP (remaining reservoir energy), recoverable reserves, HPV and favorable response to original fracture jobs (IP) could play an equally important role, if not greater, in determining the success of restimulation. In fact, studies have shown that selecting poor or underperforming wells for restimulation is likely to result in worse outcomes than random selection of workover candidates.

Studies performed to date have concluded that no selection criteria can be universally applied to every situation; rather that the selection methodology for workover candidates must be customized to fit particular situations. This paper explores the common traits shared by fields likely to have underexploited restimulation potential and suggests methodologies that should be applied to various field types. Application of the correct candidate-selection methodology to a particular field type will inevitably lead to a higher success rate of restimulation workovers and the capture of an underexploited resource.
Restimulation: Candidate Selection
Methodologies and Treatment Optimization

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Restimulation – Presentation Outline

- History of restimulation
- Common traits of areas with restimulation potential
- Case histories
- Selection methodology
- Conclusions
Prevailing Attitudes Towards Restimulation – GRI Survey

- “Cannot be economically justified”
- “We’ve had bad experiences with refracs”
- “It’s better to abandon the well”
- Restimulations < 3% of total treatments
GRI Study - Selection Methodology

Concluded that selecting wells on underperformance alone was substantially less likely to yield successful candidates than random selection in a heterogeneous reservoir.
Restimulation 2008

- Operators universally interested in restimulation because of high product prices
- Many operators are dedicating personnel to identifying candidates
- Some areas seeing a significant upward trend in restimulation activity
Common Traits of Areas with Restimulation Potential

1. Complex reservoirs with problematic initial completions
2. Plays with important technological improvements
3. Older wells that have suffered damage during production
4. Plays with multiple producing horizons that may have been stimulated with limited entry techniques
Case Studies

- Codell DJ Basin
- Barnett Shale
- Vicksburg
Case Number 1 – Barnett Shale
Barnett Shale
Common Traits 1 and 2—complex reservoir, technology evolution

- Candidate selection – better performers with 2 to 5 years of production history
- Much of Ft. Worth basin has low stress anisotropy
- Increased drainage area through fracture reorientation
- Water fracs replacing gel fracs
- Bigger secondary frac
- Some “restimulations” also adding new zones
Re-frac Re-orientation Concept

Depletion Shadow reduces rock stress due to poroelastic effect. A re-fracture will re-orient normal to original fracture until it exits depletion shadow.

Re-orientation propensity dependent on stress anisotropy
Barnett Shale Restimulation

ELKINS UNIT - NEWARK EAST

- Gas Production (mcf)
- Oil Production (bbl)
- Water Production (bbl)

Time:
Case Number 2 - Vicksburg
Vicksburg – South Texas
Common Traits 1, 2, and 4 – complex, technology evolution, multiple zones

- Original completions in 70’s and 80’s
- Very low matrix permeability: .005 to .1 md
- Multiple zones; some limited entry
- Success rate > 80%
- Key to success: highly customized selection methodology
Candidate Indicator: Quadrant Movement

Best 12 mo | 60 Prod. Months Cum

- Usually Successful
- NEVER Successful

Need detail analysis

50 % | 50 %
# Vicksburg Selection Methodology

<table>
<thead>
<tr>
<th>Candidate Indicator</th>
<th>Well #1</th>
<th>Well #2</th>
<th>Well #3</th>
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<tr>
<td>Gas Best 12</td>
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<td>5</td>
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<tr>
<td>60 Productive Months Cum</td>
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<td>(Ranking for workover review &amp; pre-production trend</td>
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<tr>
<td>Water prod. vs. Gas prod ratio</td>
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</tr>
<tr>
<td>Gas Decline Trend</td>
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</tbody>
</table>
Case Number 3 – Codell DJ Basin

Codell DJ Basin
Codell DJ Basin located on the plains east of the Rocky Mountains

Low Stress Anisotropy
Codell DJ Basin

Common Traits 1 and 2 – complex reservoir, technology evolution

- Low perm, naturally fractured, non-competitive SS reservoir
- Using better frac fluids and evolved stimulation techniques, created fractures 300’ to 400’ longer
- Real time frac supervision kept frac in zone
- Fracture reorientation is believed to an important component – many wells restimulated twice
Generalized Selection Methodology

1. Literature Review
2. Scoping Study
3. Performance Based Screening
4. Well data review
5. Identification of key drivers and indicators
6. Integrated evaluation of best candidate wells
7. Restimulation of best candidate wells
8. Evaluation of results and revision of selection criteria
Scoping Study

- Parameters Available in Public Domain

- Production
- Frac fluid volume and type
- Proppant volume and type
- Perforated interval
- Operator
- DOFP
- Pressure
- Well density
Completion Data Analysis

Average Gas Rate vs. Cum Days by Proppant Type

![Graph showing average gas rate vs. cumulative days for different proppant types. The graph indicates that Sand & RC (45) and HSP, ISP & LWP (16) have different trends over cumulative time.]
Conclusions

• Areas ripe for restimulation have one or more traits in common
• Selection methodology must be customized to fit the particular needs of a given field
• Substantial incremental reserves can be added if the correct candidate selection process is followed