Hydraulic Re-Fracturing*

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Abstract

A discussion and review of re-fracturing of both vertical and horizontal wells. Discussion of basic fundamentals of hydraulic fracturing, reasons to re-frac, candidate selection, operational considerations, and case histories.
Hydraulic Re-Fracturing

Neil Stegent, P.E.
Technology Manager - Fracturing
Re-Frac Case History Papers
(not all inclusive)

Vicksburg, S. Texas  SPE 4118
Canyon Sand, Texas  SPE 4800
Escondido Sandstone, Texas  SPE 7912
J Sand, Wattenberg, CO  SPE 7936
Undisclosed “low pressured field”, SPE 14376
Oak Hill, Cotton Valley E TX + LA  SPE 14655
Morrow, Red Fork, Atoka, OK  SPE 18861
Smackover, Mississippi  SPE 19768
Mesaverde Group, CO & NM  SPE 24307
McAllen Field, Vicksburg, S. Texas  SPE 24872
Eastern Gas Shales-Antrim, MI and Appalachian Shales  SPE 26894
Mendota, Granite Wash, TX  SPE 27933
Antrim Shale, MI  SPE 29172
Gray Sand, Cotton Valley, LA  SPE 29554
Almond/Wamsutter, WY  SPE 30480
Green River Frontier, WY
+ Piceance Basin, CO  SPE 55627
Piceance Basin, CO and GGRB, WY  SPE 56482
Viking, Ferrier, Alberta  Pet Society 99-60
Barnett Shale, TX  SPE 63030
Cotton Valley TX  SPE 63241
Codell, DJ Basin, CO  SPE 67211, 71045, OGJ 2006
Medicine Hat, Milk River, Alberta  SPE 81730
S. Texas undisclosed field  E&P 2006

SPE 134330 by Mike Vincent
Refracs - Why do they work, and Why do they Fail in 100 Published Field Studies?
25 page Paper + 4 pages of paper references (120) + 15 pages of “findings” from re-fracs (130)
Hydraulic Fracture Design

\[ C_r = \frac{k_{frac}W_{frac}}{\pi k_{zone}X_{frac}} \]

McGuire & Sikora Curves

\[ C_{FD} = \frac{k_{j}w_{j}}{k_{z}x_{j}} \]

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What is a Hydraulic Fracture?

- \( \sigma_{\text{overburden}} \)
- \( \sigma_{\text{max}} \)
- \( \sigma_{\text{min}} \)
- \( \sigma_v > 1 \text{ psi/ft} \)
- Wellbore
- Stress Profile
- \( \sigma_{\text{min}} \)
- \( \sigma_{\text{max}} \)
- \( \sigma_H \)

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What’s Fractures Really Look like........

Ideal world

Real world

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What’s Fractures Really Look like..........
Initial Hydraulic Fracture Completion:

Petrophysics

Frac Design

Production

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Reasons to Refrac:

- Improve original fracture conductivity
- Alter fracture geometry
- Restoration fracture conductivity of Proppant
  - Embedment
  - Stress cycling
  - Diagenesis
  - Scale/Fines
- Restore near-wellbore conductivity
- Stimulating “by-passed” pay intervals
- Utilize new Technology
- Re-energizing or re-inflating natural fissures
- Fracture reorientation due changes in the stress field
  - refrac often contacts “new” rock
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Increase Original Job Size
Restimulation of Oil Wells
SPE 101821

Fig. 14 – Restimulation Treatment Sizes were 135% Larger

Fig. 15 – Reservoir Pressure declined approximately 15%

- Despite pressure depletion of ~15%, refracs provided large benefits
- Refracs were designed to improve conductivity, proppant mass increased by 135%. 

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Production from restimulated wells increased by an average of 37 t/day (~ 275 bbls/Day)
Alter Original Geometry
Re-fracture due to change in rock Stress
Re-fracture due to change in rock Stress

Re-Fracture Treatment

Results in Longer Fracture

Original Fracture Grows Upward and is Short
Re-fracture due to change in rock Stress

- **Gas rate for initial frac (mscf/d)**
- **Gas rate for re-frac (mscf/d)**

Original conditions:
- Stress: 7500 psi
- Pressure: 6400 psi
- Length: 400 ft

Current conditions:
- Stress: 5300 psi
- Pressure: 4050 psi
- Re-frac length: 740 ft

Time (days):
- 0
- 730
- 1460
- 2190
- 2920
- 3650

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Restore Fracture Conductivity
Re-fracture to remove near wellbore damage

Re-Frac placed 74,000 LBS 5 PPG w/ SandWedge
Reasons to Refrac: Candidate Selection

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New Technology: By-Passed Pay

Quantify Pay Zones

DFIT – Diagnostic Fluid Injection Test

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Increased Production: Re-frac by-passed Pay Zones

- 1,818 mcf/d Average
- 810 mcf/d Average
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Re-Frac with Different Frac Design: SPE 95568

Original Frac: Viscous Polymer Gel Fluid

Re-Frac: Low Viscosity Water Frac Fluid
Re-Frac with Different Frac Design: SPE 95568
Fracture Re-Orientaion
Re-fracture Reorientation - Barnett Shale
SPE 63030

Re-Frac Reorientation Concept
Re-fracture Reorientation - Barnett Shale
SPE 63030

Original Fracture Orientation

Re-Fracture Orientation
## Re-fracture Reorientation - Barnett Shale

**SPE 63030**

<table>
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<th>Volumes</th>
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<tr>
<td></td>
<td>Refrac</td>
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</tbody>
</table>

![Graph showing gas production rate vs. cumulative days]

- Observed
- Primary and secondary fractures open
- Primary fracture open

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