SPE 170923
Granite Wash Optimization – Validating Completion and Production Techniques

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Agenda

• Area overview
• Tracer overview
• Monitoring goals
• Openhole completion test
• Stacked lateral test
• Offset well review
• Conclusions
Introduction

- Granite Wash
  - Texas Panhandle play extending into west Oklahoma
  - Multiple zones
  - Late 80’s, early 90’s saw large vertical development
  - Currently—multilateral horizontal wells

- Project Scope
  - 200+ horizontal wells

Standard Operating Process

- Well is prepared 2-3 weeks prior to stimulation operations.
- The well is evaluated for level of Chemical Frac Tracer involvement.
- During operations CFT is pumped in scheduled stages.
- During drillout and flowback operations fluid’s are sampled on a scheduled basis.
- Long term sample schedule is determined by wells response and nearby offset activity.
Tracer Overview

- Fluid tracing involves pumping unique water-based tracers in the pad and proppant-laden fluid of a stimulated stage.

- After fracture operations are completed, water samples from the flowback stream are then caught and analyzed with gas chromatography.

- Tracers are referred to as Chemical Fluid Tracers (CFT).

Sample Well Report

| Tracer Segment | Stim Date | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 0.05 to 1.00 |
| 1 | 10/7/11 | 1319 | 1219 | 1019 | 819 | 619 | 419 | 219 | 019 | 17 | 12 | 10 | 8  | 6 | 4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1
| 2 | 10/7/11 | 1219 | 1119 | 1019 | 819 | 619 | 419 | 219 | 019 | 17 | 12 | 10 | 8  | 6 | 4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1
| 3 | 10/7/11 | 1119 | 1019 | 819 | 619 | 419 | 219 | 019 | 17 | 12 | 10 | 8  | 6 | 4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1
| 4 | 10/7/11 | 1019 | 819 | 619 | 419 | 219 | 019 | 17 | 12 | 10 | 8  | 6 | 4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1
| 5 | 10/7/11 | 919 | 719 | 519 | 319 | 119 | 119 | 17 | 12 | 10 | 8  | 6 | 4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1
| 6 | 10/7/11 | 819 | 619 | 419 | 219 | 019 | 17 | 12 | 10 | 8  | 6 | 4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1

Key
- Cum Vol*: Sample Date
- Sample Type
- CFT 1300
- CFT 1000
- CFT 1100
- CFT 1200
- CFT 2000
- CFT 2200
- CFT 1600
- CFT 2400
- CFT 1500
- CFT 2100
- CFT 1900
- CFT 1700
- CFT Total ppb

Chemical Fractions

- Tracer Fluid (Gal): 284,702
- Tracer Fluid (Gal): 390,681
- Tracer Fluid (Gal): 384,086
- Tracer Fluid (Gal): 384,286
- Tracer Fluid (Gal): 404,086
- Tracer Fluid (Gal): 401,286
- Tracer Fluid (Gal): 402,206
- Tracer Fluid (Gal): 408,402
- Tracer Fluid (Gal): 415,002
- Tracer Fluid (Gal): 420,336
- Tracer Fluid Total: 4,687,544

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Monitoring Program

- Over 50% of wells monitored use multiple CFT’s
- Toe only logic
- Recycled water
  - Flowback water is piped to pits and treated
  - Use 60-80% recycled water each frac

Fracturing Fluid Recycling

- Small amounts of tracer in the recycled frac fluid are accounted for in pre-frac sampling
Z5H Example – Diagnostics

• Three CFT’s injected equally across three sections of the lateral

• Stimulation treatment tested for even load recovery across the lateral

• Overall load fluid recovery was fairly even across the lateral
  • With other wells, early heel domination is seen

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Avg ppb: 64.79, 126.73, 127.27, 318.79

T10H and T11H Stacked Lateral Test

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• Project Scope: Evaluating barriers between horizontal bedding planes and target formations.

• Both wells traced, and sampled
  • Offset verticals considered and sampled as well
Open hole completion
  - Standard for this particular formation

Originally no seats were milled
  - Decision was made to mill seats based on low tracer recovery from toe stages

Post intervention increase in production of oil and gas

K1H is stimulated 6 months prior to the T3H

The offset well communication level was unknown for the area

Recovered tracer from the K1H well does not show traced communication from the T3H stimulation treatment
Communication Test: 10 Well Project

- Fraced using three stimulation fleets simultaneously across three sections.
- Wells stimulated first receive less communication from the latter wells.
- Table below grades into tiers of exposure.

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# Wells

- Tier 1: <0 ppm
- Tier 2: 0-20 ppm
- Tier 3: >20 ppm

Communication Test: 10 Well Project (Slide 15)

Communication Test: 10 Well Project (Slide 16)
Overall Communication: 10 Well Project

3D Animation of early communication matrix

Area Specific Overall Volume Received
Conclusions

- Recycled water can be utilized, as background tracer data can be confirmed prior to use.
- New completion techniques can be tested for well response and even flow regimes.
- Interwell communication can be evaluated with mature wells and fresh offset infill wells.
- Boundary formation efficacy can be tested with stacked laterals.
- Initial flowback can give guidance on the next step required for the health of the well.
- Non-productive portions of the lateral can be quickly identified and remediation can be performed to maintain healthy production.

Acknowledgements / Thank You / Questions

The authors gratefully acknowledge the assistance and support of Linn Energy in preparing and presenting this paper.