Hydraulic Fracture Engineering

Solving your stimulation puzzle

FEATURES

- Improved fracture design.
- Onsite analysis.
- Treatment supervision.
- Post-frac analysis.
- Design optimization and economics.

Engineers at StrataGen Engineering design hydraulic fracture treatments and perform real-time on-site fracture treatment analysis and rigorous post-frac analysis to evaluate stimulation strategies and practices. Honoring and fully utilizing real data is the centerpiece of StrataGen's analysis philosophy.

StrataGen has been on thousands of propped fracture treatment jobs to help solve completion problems and optimize production economics. StrataGen is a recognized industry leader in the area of hydraulic fracture engineering with the unique capability to "calibrate" fracture models with fracture diagnostic measurements.

The most common fracture diagnostic technique is fracture pressure analysis. Analysis of fracture treatment pressure data provides insights into obtained hydraulic fracture dimensions and can quantify proppant placement problems. With these measurements, stimulation practices can be optimized and measures taken in real-time to minimize potential proppant placement problems.

Despite the development of sophisticated 3-D fracture modeling tools, hydraulic fracture behavior is difficult to predict with any degree of confidence. StrataGen integrates fracture pressure analysis with the results of other available fracture diagnostic techniques fracture mapping, specialized logging, production data analysis and well testing—each contributing key pieces to the puzzle. In many situations, however, fracture pressure is the only measured data available.

Fracture pressure analysis

Net pressure (the pressure in the main body of the fracture minus fracture closure stress) is the single most important variable in fracture pressure analysis because it is directly related to fracture length, width, and height. The technique of net pressure history matching is used to match a theoretical model net pressure to the actual or observed net pressure behavior, with potential solutions constrained by a combination of diagnostic injection behavior and engineering principles. The end result is a fracture geometry estimate that is firmly linked to the actual treatment behavior.

Fracture entry friction, the combination of perforation friction and near-wellbore friction, is also characterized using fracture pressure analysis. Near-wellbore friction is an indicator of fracture initiation complexity and is a common cause of near-wellbore bridging screenouts. The ability to characterize fracture entry friction is key to evaluating the success of remedial measures and making "on the fly" changes to completion design.

To enable quick and useful onsite extraction of feedback from fracture pressure data, StrataGen has pioneered and developed diagnostic injection procedures that are performed before and during a fracture treatment. These simple and inexpensive diagnostic procedures provide fracture pressure analysis "anchor points" such as closure pressure, leakoff and net pressure that further authenticates potential analysis solutions.

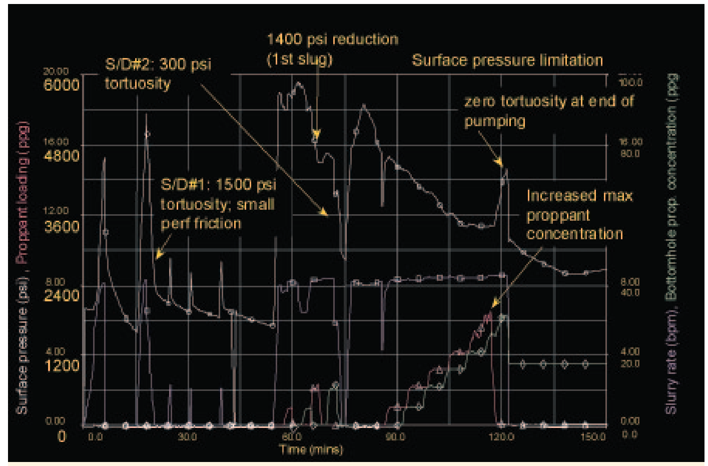
Real-data fracture pressure analysis can be used effectively for several common fracture engineering tasks:

- **Optimization of basic treatment and completion design** In an area where many fracture treatments are successfully performed, fracture treatment and completion design may be refined to improve well economics.
- **Solving fracture entry problems** In areas experiencing bridging screenouts, near-wellbore fracture tortuosity and perforation restrictions may be evaluated onsite in real time, thus allowing implementation of the correct remedial measures.
- **Routine onsite pad volume sizing** To accommodate geologic variability (based on observed fracture fluid leakoff) pad volume is optimized to shorten closure time, implement a tip screenout design or avoid a premature tip screenout.
- **Design for a new fracturing environment** Real-data analysis provides a tool to shorten a traditionally long and expensive learning curve. This technique reduces execution risk while pursuing an aggressive initial fracture strategy and assists with the evaluation of well performance.

Onsite, real time

StrataGen engineers have performed onsite real-time fracture pressure analysis in environments including frac and packs of 2-Darcy sandstones, horizontal stimulations, waterfracs and tight gas fracs at greater than 17,000 ft.

Onsite, the focus is on identification of fracture entry friction problems, optimization of pad sizing, and proppant scheduling. Follow-up analysis includes integration with other fracture diagnostics data to obtain the best possible understanding of fracture growth behavior to evaluate alternative designs and strategies. With this approach, true economic fracture treatment optimization can be achieved. Please contact us to learn how StrataGen's hydraulic fracture engineering can help you.



Prior to this treatment an adjoining well with a similar completion history experienced a "pressure-out" on pad, making placement of a propped treatment impossible. In response, real-time fracture pressure analysis was employed to quantify and minimize proppant placement problems.

As shown in the figure above, the rate stepdown test following the second KCl injection (S/D #1) showed that near-wellbore fracture tortuosity was extremely high at 1500 psi. In response, several proppant slugs were planned as early as possible during the propped frac pad. Tortuosity continued to increase during the propped frac pad, forcing injection rate to be cut to stay below the 6000 psi maximum surface pressure. However, as soon as the proppant slugs arrived downhole tortuosity was dramatically reduced, enabling an increase in injection rate. The propped fracture treatment could be successfully placed, even allowing an increase in maximum proppant loading from the designed 4 - 6 lb/gal to better accommodate higher production rates.

Significant reduction in near-wellbore friction due to proppant slugs allowed successful placement of all proppant and also allowed real-time onsite increase in maximum proppant loading from 4 - 6 lb/gal to obtain sufficient fracture conductivity for this moderate-permeability well.

The initial post-frac production response was more than 3 MMcfd, about three times the pre-frac rate. Since the offset well experience suggested this well could not be propped fracture treated at all, real-data fracture diagnostics yielded an increase in NPV of $1.6 million over three years of production.

StrataGen, Inc.
Energy Center II
575 N. Dairy Ashford, Suite 300
Houston, Texas 77079 USA
T: +1-281-921-6400
F: +1-281-921-6401
StrataGenEngineering.com

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