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Seizing the Moment:
How Real-Time Fracture Measurements Drive Game-Changing Performance

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Do you have to calibrate your model / algorithm / workflow to the injection fluid properties, wellbore traverse, geophysical rock properties or is it a plug and play for any well any treatment type?

Our model and workflow are designed to function independently of injection fluid properties, frac provider, wellbore traverse, or geophysical rock properties. We aim for a solution that delivers consistent results without relying on subjective calibration. Our algorithm is trained on a robust dataset, using stages with the highest raw data quality, which closely reflect current operational conditions. This allows us to provide reliable insights across a variety of treatments and well environments.

Another powerful application of our technology is in identifying unique geophysical characteristics and tailoring custom treatment schedules. For example, we've collaborated with partners to develop stage-specific schedules that adjust fluid and proppant application based on the specific facies of the lateral's landing zone. This ensures even more effective and targeted completion strategy, to maximize the effectiveness of our operations.

Have you substantiated this type work with a bottomhole pressure gauge?

Yes, we have substantiated this work using bottomhole pressure gauges. We've conducted multiple jobs with both surface and downhole pressure gauges to validate our approach.

Comparisons between surface and downhole data have shown highly analogous responses, confirming the accuracy of our surface-based measurements. While surface gauges exhibit a slight reduction in amplitude due to damping effects, the key pressure signals and trends remain consistent. This demonstrates that surface pressure gauges provide reliable and actionable insights for optimizing hydraulic fracturing operations without the need for more costly and invasive downhole instrumentation.

You mentioned 1 hz (1 sample/second) pressure measurements but are you also looking into higher sampling such as 50 hz.?

Yes, we have explored higher sampling rates, such as 50 Hz, in the past and continue to investigate their potential through our R&D efforts. Using higher sampling rates allows us to analyze frequency bands and signal decomposition in greater detail, enabling us to correlate specific frequencies with fracture dimensions and characteristics.

Additionally, higher sampling rates help us capture mechanical signals more effectively, such as those associated with plug slips. While our current standard focuses on 1 Hz sampling rates, we are actively researching ways to broaden our capabilities by including high-frequency data for future applications. This is part of our ongoing commitment to enhancing the precision and robustness of our analysis techniques.

Is there a typical frequency range observed (hz) for the pressure variations, and is there a different range observed using high frequency gauges?

The observed frequency range does depend on the sampling rate of the gauges, and according to the Nyquist theorem, the maximum measurable frequency is half the sampling rate. Rock behavior cycles generally occur at low frequencies, making 1 Hz sampling adequate for capturing relevant patterns.

When using lower sampling rates, we ensure the data is not averaged, filtered or clipped, preserving the signal integrity. The "frequencies" we observe in the technology are effectively the number of pressure events within a given time interval. The signal is decomposed into its components to better understand the subsurface behavior. This ensures our analysis remains robust and applicable across different sampling rates.

What are some of the real time modifications you have recommended?

Our primary controllable inputs are related to the treatment design, including fluid rate, sand concentration, chemical additives, and diverters. These inputs are the main levers we can adjust in real time. Depending on the specific application and operational goals, we may use one or all of these tools.

The most common real-time adjustments are as simple as tweaking sand concentration and fluid rate to optimize fracture performance. For example, we've used the Active Guidance algorithm to dynamically adjust sand and fluid schedules, to increase the effectiveness of our operations.

Another example includes optimizing stage design with A/B schedule decisions to invest more in high performing stages (A Schedules) and less in low performing stages (B Schedules). By tailoring adjustments to these real-time measurements and operator strategies, we help improve both operational efficiency and cost-effectiveness.

Some formations require high HVFR/crosslink fluid systems. How is frequency and amplitude effected by those jobs vs purely low FR loading slickwater? Any signal dampening?

High HVFR or crosslinked fluid systems tend to exhibit more signal attenuation (dampening) due to their higher viscosity and scattering effects. This can impact the sharpness of fracture signals, making them harder to detect. In contrast, slickwater systems preserve a broader frequency spectrum and sharper amplitudes, allowing for clearer detection of fractures and transient events.

A key assumption in our analysis is that the fluid is incompressible, which simplifies the interpretation of pressure signals and allows us to focus on how different fluid systems influence frequency and amplitude. To account for these variations, we concentrate on the dominant frequencies of rock signal to ensure accurate insights across diverse fluid types.

Are fracture frequency and fracture intensity measured or are they derived or analyzed from the pressure? Frequency and intensity are related to the pressure gauge or the pressure data, right?

We are measuring frequency from the variations in the pressure signal. Intensity is derived using both frequency and derivative amplitude from the pressure measurement. Fracture intensity serves to quantify stress release events during operations, providing a measure of how effectively fractures are being created.

What is the unit and definition for Fracture Effectiveness?

Fracture effectiveness is a non-dimensional/unitless metric of the cumulative fracture intensity. Effectiveness serves as a quantification of total stress transfer during the course of a stage. This provides a single metric that indicates how effectively the energy contained in high-pressure fluid was transferred into fracturing events and provides a metric to compare stage to stage and well to well.

Have any of these pressure measurements been used to more accurately analyze a plug issue (various failure modes) versus a cement isolation or formation breakdown?

What we see with a loss of integrity whether it be plug or cement related is a loss in fracture frequency. We have tested various offline analysis methods to evaluate energy changes and pressure stability, as well as real-time techniques to identify patterns in pressure releases to be more predictive of the failure mode. While it is challenging to fully account for these complexities, it is something we are actively working towards to improve our understanding and analysis capabilities.

Have you utilized this process during refracs, and if so, do you see a different frequency/amplitude response compared to newly frac'd wells?

We are exploring future opportunities but have not yet applied this technology on any recompletions. What we anticipate seeing in these applications are low intensity and frequency within the measurements in the beginning portion of our stage until we begin to successfully create new fractures and stimulate un-tapped reservoir.

Did the wells in Pads A through D referenced in the case study have similar reservoir properties, wellbore/formation communication, perforation strategies? Were the total proppant / fluids volumes similar across all wells?

Regarding the reservoir, the wells were landed in two separate intervals, with two wells in the upper zone and two in the lower zone on each pad, respectively. All other parameters—such as perforations, stage spacing, and proppant tonnage—remained consistent across the pads, with the only variable being fluid volumes.

The results presented demonstrate the effectiveness of utilizing these real-time technologies to maintain our applied energy around the active treating well. This was achieved through the application of our Active Guidance algorithm, which dynamically optimizes fluid and proppant schedules to maximize fracture efficiency, and FDI Mitigation, which actively minimizes fracture-driven interactions to ensure consistent stimulation across the pad. Together, these tools enhance operational performance and resource recovery, even in complex reservoir conditions.

Can your technique help optimize well placement and spacing?

Yes, our techniques can play a critical role in optimizing well placement and spacing. By analyzing these real-time measurements, we gain insights into fracture propagation and interactions with nearby wells. This information helps identify areas of high and low stimulation efficiency, revealing optimal well spacing to maximize resource recovery while minimizing interference, such as fracture-driven interactions (FDI). Layering in stage-level Post Frac Pressure Decay analysis to determine half-lengths, effective ISIPs and fluid efficiency further enhances our understanding of the area created by our stimulation and any potential effects of depletion.

This approach provides a deeper understanding of subsurface conditions, enabling operators to refine their field development strategies. By incorporating these insights early in the planning process, operators can make more informed decisions about well placement and reduce the risk of underperforming wells or over-capitalizing on tightly spaced completions.

Interesting application of machine learning and AI. Are you using traditional CPU processing or are you utilizing GPU computing to make your model more robust.

We currently use traditional CPU-based processing for our machine learning and AI models. While this approach has been effective, we are actively exploring GPU computing to enhance the efficiency and scalability of our models.

By leveraging GPU capabilities, we aim to accelerate data processing and improve the performance of our algorithms, particularly in handling large datasets and complex real-time analyses. This is part of our ongoing efforts to make our machine learning and AI models more robust and capable of delivering even faster, more accurate insights in hydraulic fracturing operations.

Many years ago, Dr. Jim Surjaatmadja told me that a fracture propagates like a wave, and you want the frac treatment to 'ride the wave'. Is that a simplistic way of looking at how we do things, or are we not able to truly achieve that to optimize fracs? Velocity issue?

This question was not able to be answered in the time allotted. However, they have connected on LinkedIn and continue to enjoy discussions around this question.

We welcome the opportunity to further discuss these and any other questions you may have: info@shearfrac.com

Or visit our Website: https://shearfrac.com/contact-us/