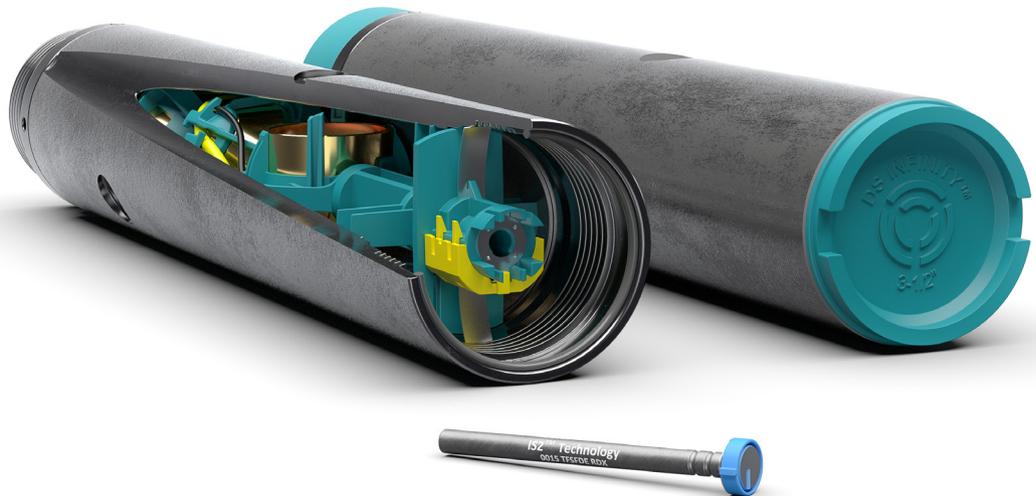




DynaEnergetics DS Intensity™ Case Study

DynaEnergetics' DS Intensity™ Perforating System with LoneStar Charges Improves Frac Performance; Delivers Economic and Environmental Benefits in Appalachia Natural Gas Well



Overview

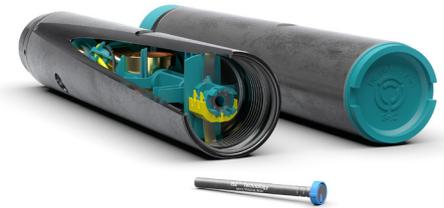


THE CHALLENGE

Natural gas wells targeting Appalachia's Marcellus Shale formation often feature very long laterals that can present unique challenges during the hydraulic fracturing process. For instance, a leading Exploration and Production (E&P) company operating in the region was having difficulty achieving its targeted pump rates in the toe section of its Marcellus Shale wells.

THE SOLUTION

Instead of making costly and time-consuming adjustments to its well design, engineers from the E&P company considered changes to the perforating system. The engineers conducted a comparison of DynaEnergetics' DS Intensity™ perforating system equipped with LoneStar charges versus the incumbent perforating gun. The test evaluated formation breakdown pressure, treating rates and treating pressure in two side-by-side, 45-stage wells.



THE RESULTS

In the head-to-head test, DS Intensity enabled the E&P to:

1

Achieve its designed pump rates at the toe of the well

2

Reduce the amount of water and frac chemicals required to complete the well

3

Reduce total pump time on the well by nearly 7 hours

4

Lower the total completion cost

A Closer Look

Many of the longest laterals drilled by North America's unconventional oil and gas industry are in the Marcellus Shale. One of the challenges of completing these wells is injecting frac fluid into the formation at optimum rates and pressures, especially at the toe. Successful completions often require multiple downhole runs, re-perforations and high pumping horsepower to overcome suboptimal injection rates.

A Marcellus-focused E&P company was using perforating guns and shaped charges from a well-regarded manufacturer whose products are commonly used in the region. The company's engineers wanted to know if switching to a more advanced perforating solution would enable higher volume injection rates with better cluster efficiency and well productivity.

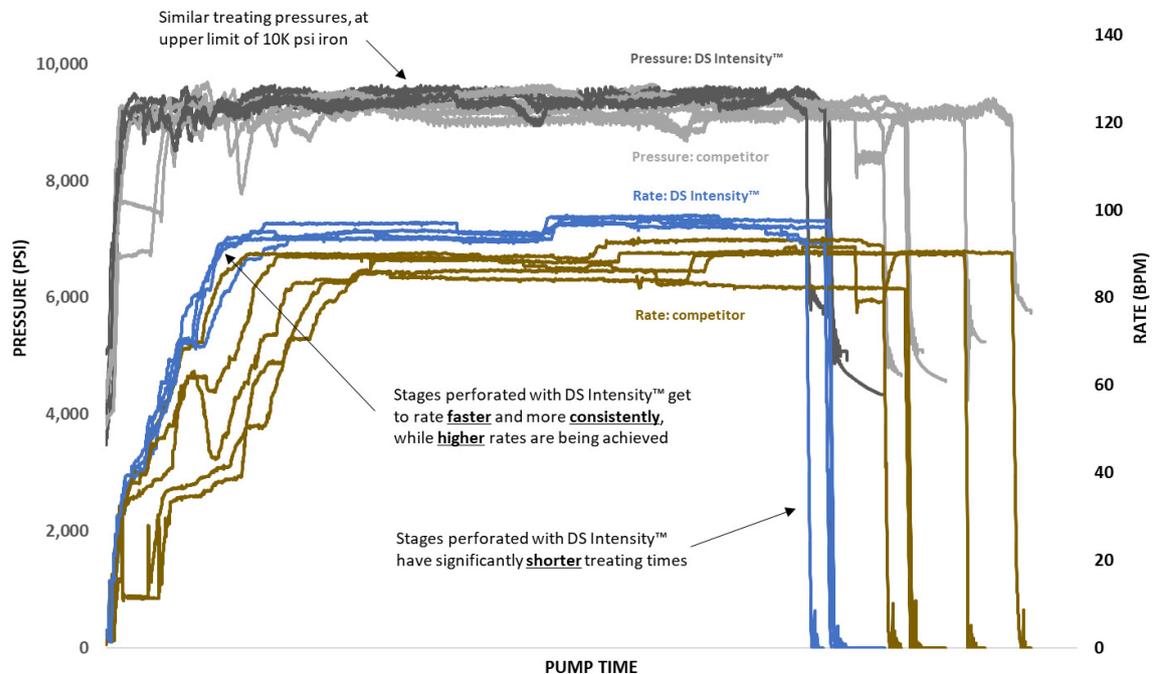
The E&P company discussed its objectives with DynaEnergetics, which was having excellent success with its DS LoneStar™ single-shot perforating system in the Permian Basin. Since the E&P company required a multi-shot system for its Marcellus wells, DynaEnergetics designed DS Intensity, a 3 ½" perforating system equipped with multiple LoneStar charges.

The Field Trial

In its test of the two perforating systems, the E&P company chose a pair of adjacent wells on the same pad. For both wells, the area of flow, phasing, and number of perforating clusters were the same. Additionally, the pressure in each well was similar throughout the treatment schedule, as dictated by the pressure rating of surface equipment.

The test revealed the well perforated with DynaEnergetics' DS Intensity and LoneStar charges achieved consistently higher injection rates, arrived at rate faster and more consistently, and required significantly less treating time.

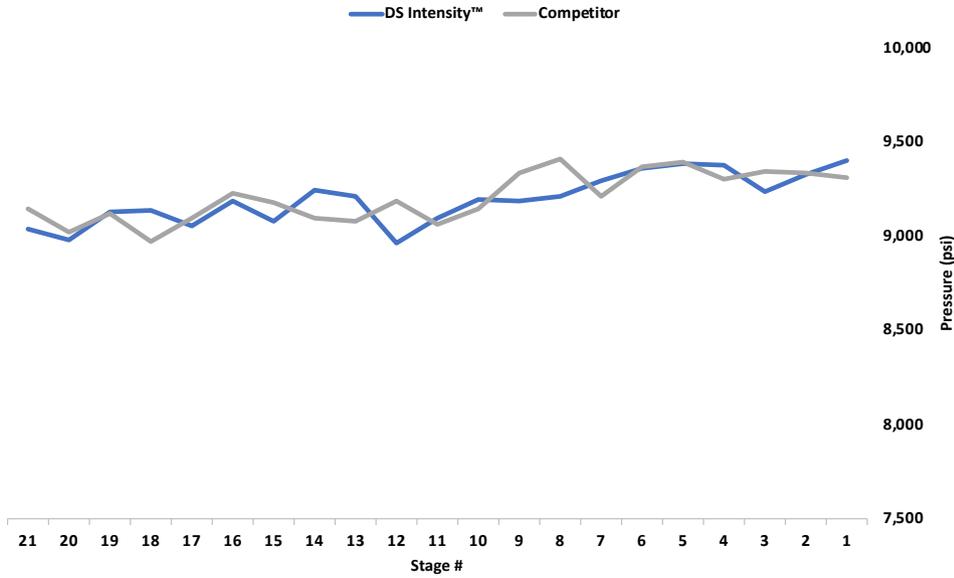
PRESSURE AND RATE CURVES



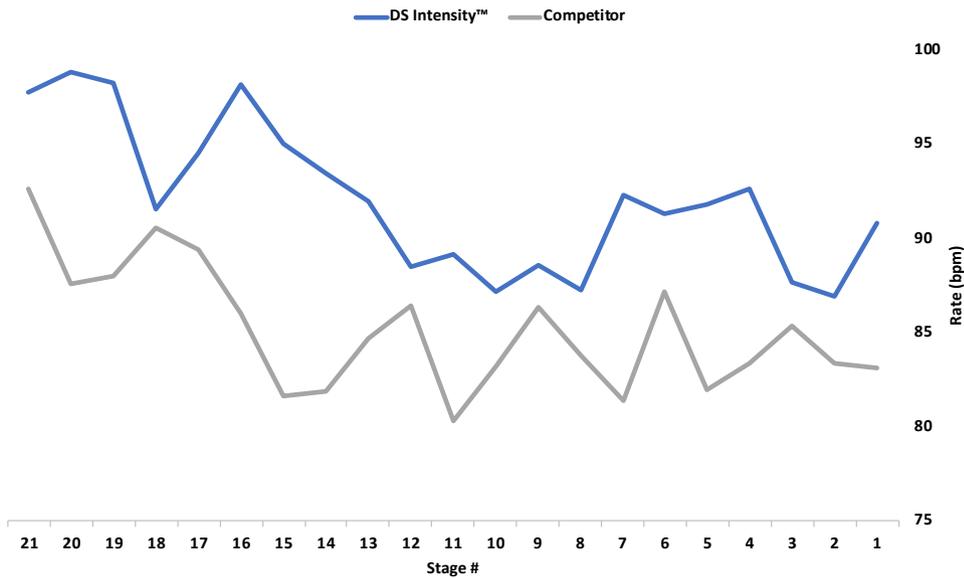
The charts below show the average rate and average pressure per stage in the well perforated by DynaEnergetics vs. the competitor. Each stage in the graph was at a similar depth and used similar chemicals, but the well perforated by DynaEnergetics achieved significantly higher flow rates than the competitor's wells.



Pressure



Rate



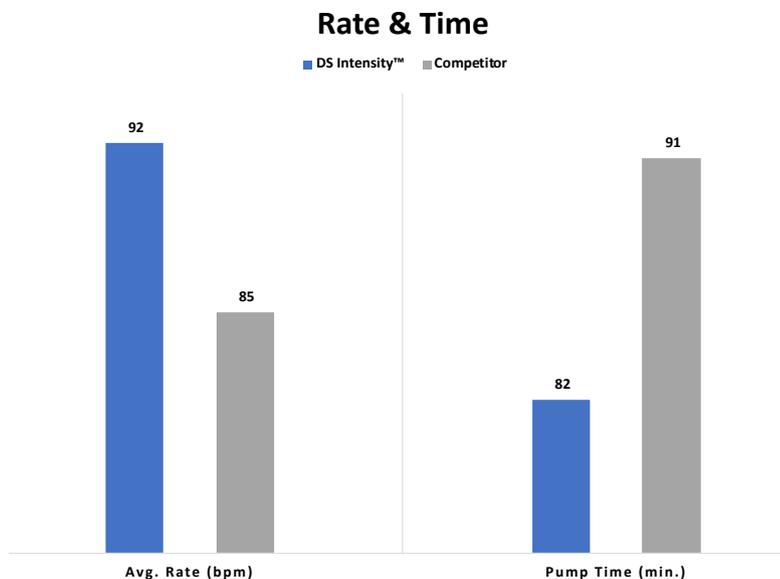
The chart on the right shows averages for pump rate and pump time:

Pump Rate: The flow rate of the well perforated with DS Intensity was consistently 7-10 barrels per minute (BPM) higher than that of the competitors' well, which was treated with the same pressures and entry-hole diameter (EHD).

Higher rates potentially result in better stimulation treatment, and ultimately, better production results.

Pump Time: On average, pump times with DS Intensity were 10 minutes shorter per stage.

Shorter pump time equates to direct savings from the frac ticket (in this case \$750 per stage), and less water consumption, which is significant for frac operations in Appalachia.



The Bottom Line

- 1 The higher cluster efficiency of DS Intensity resulted in better stimulation treatment and ultimately better production results.
- 2 Stages perforated by DS Intensity systems get to rate faster, reducing pump time by an average of 10 minutes per stage, reducing chemical, water and fuel usage, and reducing environmental impact.
- 3 Higher Rates: Consistently 7-10 BPM higher rates achieved using DS Intensity with LoneStar charges at the same treating pressures and EHD.
- 4 Lower overall completion cost.

The LoneStar Difference

LoneStar formation-tuned shaped charges are unmatched in the explosive net energy delivered to the formation, as well as entry-hole uniformity. The charges deliver large, ultra-consistent entry hole diameters that enable greater area open to flow and greatly increased formation contact area. LoneStar charges have proven a near 100% cluster efficiency, and a significant reduction in treatment pressures. LoneStar charges are available in an in-plane, single-shot perforating system called DS LoneStar, and in a multi-shot system called DS Intensity™. Both are available in externally oriented and standard models.