Proppants? We Don't Need No Stinking Proppants!

THE SETTING

- **Cotton Valley SandstoneTight Gas (0.005 – 0.01 mD)**
- **8,000' – 11,000'**
- **Pore Pressure Gradient 0.3 – 0.4psi/ft**
- **Oakhill and Carthage Fields, East Texas**

THE BACKGROUND

Hydraulic fracturing is the key technology to develop tight oil and gas reservoirs and millions of dollars have been spent researching fluids, proppants, and fracture models, yet there remains much controversy about how to optimize a fracture design.

Fracture treatments in the Cotton Valley Sands have historically incorporated massive volumes of gel and sand (in many cases over 1,000,000 lbs of sand per stage). Successive infill drilling programs and subsequent reservoir depletion necessitated a change to lower cost completions, and smaller fracs were pumped with unfavorable results.

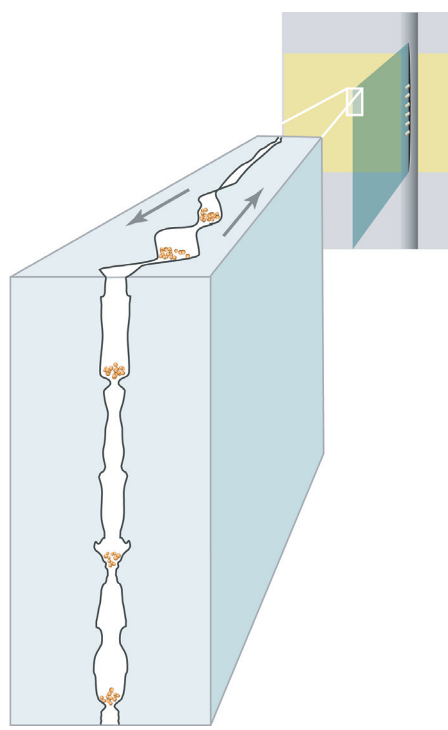
In 1995, Pinnacle engineers working for Union Pacific Resources (UPR), now Anadarko Petroleum Corp began to think "out of the box" to create a new fracture treatment strategy for the Cotton Valley, which would ultimately revolutionize fracture treatments in many other low permeability reservoirs. Waterfracs (fracture treatments using treated water and very low proppant concentrations) were reintroduced after an absence of many years and proved to be very successful in this reservoir.

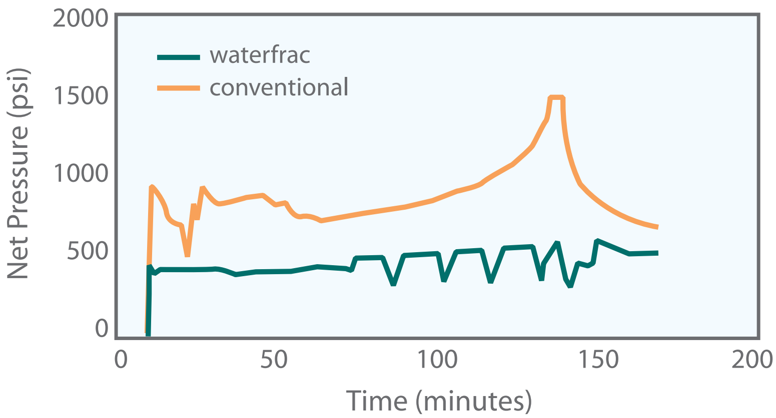
PINNACLE PERFORMS

Pinnacle engineers, some working for UPR at the time and some working in the Pinnacle Rock Mechanics Center in Delft performed studies looking at the reasons for success (or lack thereof) of then current fracture treatments. Key findings were that some wells had produced very well following mini-fracs (no proppant) and cases where found where propped frac treatments were severely overflushed, yet produced normally. Could a fracture retain adequate conductivity even in the presence of little or no proppant? If so, the following benefits to a fracturing operation would have a huge impact:

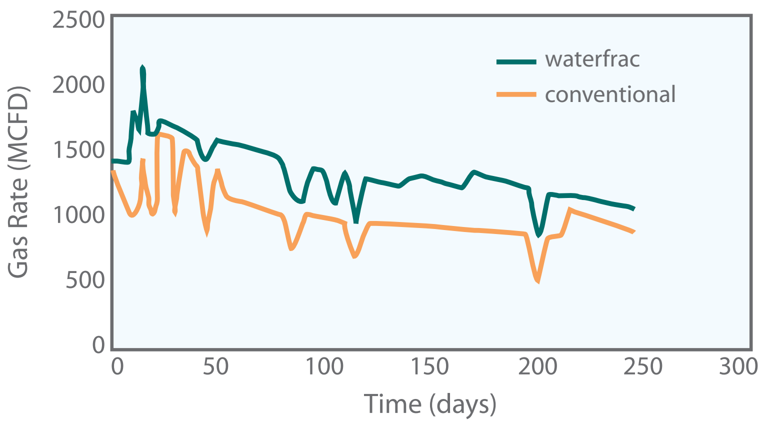
- Residual fracture aperture due to rough surfaces can form a very conductive path.
- Gel residue and even proppant can impair fracture permeability and its ability to cleanup.
- Fracture extension and cleanup is easier with low viscosity fluids.

This illustration shows two of the mechanisms which may provide conductivity even in the absence of significant proppant concentrations. The vertical portion of the fracture illustrates the surface roughness and asperities which limit complete closure of the fracture while the view of the fracture from the top looking down shows the offset of the two fracture faces and lack of alignment at closure. Both mechanisms allow the trapping of local nodes of proppant that also assist in retaining some fracture conductivity after closure.





Comparison of net pressure measured during a waterfrac and a conventional frac in Oak Hill Cotton Valley.



Production comparison of waterfrac and conventional frac from the Carthage Field pilot.

Hydromechanical response, existing literature, cores and production data were studied and modeled for the Cotton Valley, and it was determined that this reservoir was an excellent candidate for waterfracs. Three "pilot" waterfracs in different areas of Oak Hill were performed in the Cotton Valley to evaluate the performance of this newly reintroduced technique against that of "conventionally" fractured wells in each area. More details can be found in SPE 38611.

THE RESULTS

Net pressure histories from these three wells showed a flat slope and low net pressure, indicating good fracture extension, whereas net pressure from "conventional" jobs generally increased throughout the treatment, indicating growing resistance to the frac, likely within a region close to the wellbore. in all three cases, production comparisons for the first 8–14 months and beyond showed consistently better production rates for the waterfrac wells than for the conventionally fractured offsets. Additionally, treatment costs for the waterfracs ranged from about one-sixth to one-half those of the conventional fracs with cost savings per frac ranging from $45,000 up to $185,000, depending upon the size of the conventional frac treatment. The waterfracs clearly achieved better stimulation at lower cost than conventional fracs. Since this project, Pinnacle engineers have successfully introduced waterfrac technology to many other regions of the world.

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