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Slickwater Fracturing – Food for Thought

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Abstract

The evolution of fracturing technology has provided the industry with numerous advances, ranging from sophisticated fluid systems, to tip screen out designs, to propagation modeling. Interestingly, these advances have typically been focused on ‘conventional’ designs which utilize a cross-linked fluid system. However, as the development of unconventional (tight gas, shales, coal-bed methane etc) or underpressured reservoirs has increased, so has the demand for innovative hydraulic fracture designs. The most recent of these design changes has been the popular method of placing proppant with slickwater, linear gel or hybrid treatments.

Although our industry has significant expertise in fracture design, most of our experience has been in conventional cross-linked fluid systems. However, there are many aspects of cross-linked fluid design that either do not apply to slickwater treatments, or in some cases are exactly opposite.

This paper will begin by reviewing the motivation, benefits and concerns with slickwater fracturing, and discuss why this seemingly ‘old’ method has regained popularity over conventional cross-linked designs in many reservoirs. In addition, the authors will detail some of the important theories related to slickwater fracturing, including fracture width and complexity, proppant transport and settling, and conductivity requirements. In each case, emphasis will be placed on the different strategy that must be employed compared to cross-linked fluid designs, and highlight the mistakes or misunderstandings that are frequently made.

Where appropriate, lab testing, field measurements, reference material and other resources are presented to support the observations made by the authors. This paper will serve as a resource to any engineer or technician who is designing/pumping slickwater fracs, or who is considering this technology for potential application. By applying the concepts presented in this paper, engineers will be able to appropriately evaluate the potential benefits of using this technique in their completions, as well as draw on the experiences of others to take full advantage of this technology.

Introduction/Motivation

Hydraulic fracturing is arguably one of the most leveraging completion technologies, particularly in gas wells. This practice has also been a key factor in unlocking the potential of unconventional gas plays, such as coal-bed methane, tight gas and shale gas reservoirs. However, shortly after the first commercial fracture treatment was performed in 1947 using gasoline-based napalm gel frac fluid, two primary design parameters were established: 1) fractures created by “hydrafracs” tended to heal unless a propping agent was placed, and 2) frac fluids required elevated viscosity to create adequate width and proppant transport, and to minimize leak offⁱ.

Approximately 20 years later guar-based crosslinked fluids were introduced and, along with their synthetic counterpart, became the mainstay of fracturing fluidsⁱⁱ. By the 1980’s it was not uncommon for operators to place massive hydraulic fractures (MHF) in excess of 2 million lb_m of proppant, utilizing 60 pptg guar crosslinked gelⁱⁱⁱ. However in 1997 a relatively (in)famous case study in the East Texas Cotton Valley formation purported that “we don’t need no proppants”^{iv}. This study laid the foundation for the technology that induced nearly a 180 degree reversal from the MHF treatments a decade earlier, and quickly spread to other areas^v. The driving factors of this “waterfrac” phenomenon were primarily tied to three reasons: 1) the necessity of cost cutting as commodity prices fell, 2) the reservoirs being fractured were either depleted or lower permeability and as such were not able to effectively “clean-up” the gel from the fracture, and 3) the recognition that fractures were not performing as well as expected (much shorter effective half lengths than placed/designed). In fact, the primary conclusion of SPE 38611 was that “waterfracs are successful because they achieve, at a lower cost, the *same inferior stimulation* as a conventional job with inefficient cleanup” (emphasis added).