Frac Sand Quality: How Low Can You Go?

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Summary

Theory / Method / Workflow

The development of the Montney and Duvernay formations, like most North American formations, is capital intensive. The geology of unconventional wells is not as indicative, in a traditional sense, as conventional wells, since the matrix permeability is extremely low. Conventional engineering methods taught in Universities for a century such as Darcy's law and other reservoir engineering principles had to be and are still being improved for unconventional wells. The actual production of wells will not be known in its entirety for a decade after the completion which makes the iterative and empirical approach challenging. Traditionally in conventional wells, the proppant on conventional wells included 30% premium products such as resin coated sand and ceramics, where unconventional wells uses 95-99% sand. Furthermore, on the initial change of industry in 2003 in the USA and 2006 in Canada to significant unconventional wells, the tier 1 sand supply was completely used up in the USA and Canada was put at a distinct quality of sand disadvantage. In the USA, the use of tier 2 sand has led to tier 3 and 4 sands, and such applications as mono-mesh (no sorting of sizes into 30/50, 40/70, 100 mesh, etc), not drying the sand (operational adjustments to measure and pump damp sand), the use of very unprocessed sand without putting it through even the normal wet process, and micro-plants where mini mines are put 1 mile from pad of wells with a much lower drop in quality. The lab measurement conductivity of conventional lab testing does not correlate to the sometimes fantastic production of the wells… but not always. We have collected the largest sand quality database in North America and we will report on the production of the a Montney and Duvernay case study showing the use of tier 1 and inferior sands by actual production. We will correlate that to the adjusted unconventional methodology of sand selection.

Results, Observations, Conclusions

In conventional wells, frac sand conductivity directly correlated to production in most well as the frac pack was the choke on the well production. In the unconventional wells, other properties of sand were found to be more important than conductivity, such as angularity of the sand which normally results in a lower conductivity when using the conventional lab analysis. In order to match the empirical, actual production results, it is postulated that the angularity of the sand in a slickwater velocity stimulates the formation through erosivity, the formation fines as well as broken frac sand grains help prop the natural fractures much like 100 mesh sand does, the dimensionless conductivity

In the Duvernay, there was a significant production response to using extremely high proppant intensities using low quality sand up to 4 tonnes / metre of horizontal lateral length, while at the same time using a small amount of premium proppant in the near wellbore region. Traditionally in 20 years of previous SPE paper writing with the only frac database for those decades, only one proppant quality was the optimal one to use in conventional vertical wells.

In the Montney case study off of the main fairways, the production rates were lower, the use of tier 2 sand was done in 65% of the wells. This was indeed an unexpected observation having more than half of the sand being local Canadian sand. The production comparisons showed the tier 2 sand having better production than the premium proppant wells.

The significant cost savings of local sand had higher production, lower costs and more secure supply in higher volumes compared to importing sand by rail from the NE USA.

Novel/Additive Information

There is very little research on the actual success or failures of where to use non-tier 1 frac sand. This significantly impacts the profit of operators, and the control of the one thing you can see in the same quarter as the drilling and completions, the costs, while looking at the actual production impacts that can't be modelled by the reservoir simulators.

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