Improving Proppant Placement with Thin Fracturing Fluids through Job Pressure Analysis in an Unconventional Field in Saudi Arabia

Jose I. Rueda[1], Ali Momin[1], Karim Mechkak[1], Khalid Asiri[1], Ibrahim Arnaout[1], and Kirk Bartko[1]

[1]Unconventional Resources, Aramco, Dhahran, Easter Province, Saudi Arabia.

ABSTRACT

Slickwater and hybrid fracturing are the techniques mostly used in unconventional source plays worldwide. Proppant placement using these fracturing techniques in an unconventional field in Saudi Arabia, was found to be initially very challenging, until a systematic approach was followed to understand the pressure behavior during the fracturing jobs. Every slickwater and hybrid fracturing treatment was analyzed using different diagnostic plots, both real time and post–job, to understand better the formation of the proppant bed (dune) and the equilibrium dune height. This analysis helped us to link some certain pressure behavior with the stages of the formation of the dune or proppant bed. The main diagnostic tool used for this analysis was the standard Nolte-Smith Net Pressure plot, which presented different behaviors for hybrid and slickwater fracturing designs. It was observed that in slickwater jobs, the Nolte-Smith slopes for the different ramps of the same job followed a positive trend from slightly negative to values between 1 and 2 in the last ramps. This pressure behavior, changes in the slope, was associated with the different stages of formation of the dune or proppant bed. Negative to low positive slope values were associated at early stages, when settling was the proppant transport mechanism that governed the formation of the dune, intermediate values of the Nolte-Smith slope were associated when all settling, rolling, and reptation transport mechanism played a big role, and finally slopes greater than one when reptation was the main transport mechanism to continue forming the proppant bed laterally. Once a good understanding of the Nolte-Smith slope was obtained, the lessons learned were applied in real time for the execution of the jobs, and our proppant placement targets were achieved. Applying this innovative pressure interpretation technique, proppant placement was improved from less than 100 klbs in the initial fracture treatments, to 625 klbs of proppant per job, decreasing significantly the number of premature screen outs. This presentation will summarize all the lessons learned that were applied in this field to improve the proppant placement using slickwater and hybrid fracturing, which could be applied in other fields with similar proppant placement issues, and similar state of stress regime. There is nothing similar in the industry literature that could be found for this purpose.