Applications of Diagnostics to Measure the Magnitude of Near-Wellbore Pressure Drop and its Importance in Perforation Cluster Design for Effective Stimulation Distribution in Shales

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Thursday October 14, 2021, 9 a.m. Central Time

Dr. Somnath Mondal, Research Production Technologist in the Unconventionals Technology team at Shell, will speak on Thursday, October 14, 2021.

The topic is "Applications of Diagnostics to Measure the Magnitude of Near-Wellbore Pressure Drop and its Importance in Perforation Cluster Design for Effective Stimulation Distribution in Shales."

Abstract

In a typical step-down test (SDT) conducted during a hydraulic fracturing pumping stage, the injection flowrate is reduced in four or five abrupt decrements or "steps", each of duration long enough for the rate and pressure to stabilize. The pressure-rate response is used to estimate the magnitude of perforation efficiency and near-wellbore tortuosity.

Data is presented from field tests from fracturing stages with different completion architectures across multiple basins including Permian Delaware, Vaca Muerta, Montney, and Utica. Two SDTs with clean fluids were conducted in each stage - one before and another after proppant slurry was injected. In past SDT analysis, the pressure drop due to near-wellbore tortuosity is assumed to be proportional to the flow rate raised to an exponent, $\beta = 0.5$. Results from the field trials show that (1) initial β (before proppant slurry) is typically around 0.5, but the final value of β (after proppant slurry) is approximately 1, likely due to the erosion of near-wellbore region by the proppant slurry, and (2) assuming $\beta = 0.5$ for after proppant slurry SDT overestimates perforation pressure drop.

A new methodology of SDT interpretation is presented that incorporates the increase in β due to proppant slurry erosion. Hydraulic fracturing modeling, calibrated with optic fiber data, demonstrates that the stimulation distribution effectiveness must consider the interdependence of proppant segregation in the wellbore, perforation erosion, and dynamic near-wellbore tortuosity. The workflow presented here shows how the uncertainties in the magnitude of near-wellbore complexity and perforation size, along with uncertainties in hydraulic fracture propagation parameters, are critical to consider for a robust perforation cluster design.

Biography

Som Mondal is a Research Production Technologist in the Unconventionals Technology team at Shell. He supports technology maturation and digitalization, production engineering, completion optimization through integrated diagnostics, design, and execution of field trial programs, and in wellbore, reservoir, and geomechanics modelling. Novel tools and workflows on production and real-time optimization developed by him have been recognized through Technology and Global Development Awards in Shell and implemented across all Shales assets. He has 14 years of research and industry experience and has authored over 25 journal publications and conference proceedings. He holds a PhD and MS in petroleum engineering from University of Texas at Austin and a BS in chemical engineering from BITS Pilani, India. His current technical interests are in integrated diagnostics, real-time decision making, systems engineering, and enhanced geothermal.