

Optimization of Perforation Phasing for Improving Uniformity of Proppant Distribution Between Clusters

Dr. Egor Dontsov, ResFrac Corporation

Thursday, May 4, 2023, 9 a.m. Central Time



Dr. Egor Dontsov, Chief Scientist, ResFrac Corporation, will speak on Thursday, May 4, 2023, at 9:00 a.m. Central Time.

The topic is “Optimization of perforation phasing for improving uniformity of proppant distribution between clusters.”

Abstract

Limited entry technique is often employed to achieve uniform flow distribution between perforation clusters during hydraulic fracturing treatment. However, the proppant distribution between clusters will not necessarily be uniform, even if the slurry distribution is uniform. There are two mechanisms that contribute to the non-uniform proppant distribution. The first one is related to particle setting in the wellbore. As the average slurry velocity reduces from one cluster to another, the ability of flow to suspend particles reduces. This introduces a bias in proppant concentration, so that there is more proppant at the bottom of the wellbore. As a result, perforations located at the bottom of the well receive more proppant than their counterparts located at the top. The second mechanism is also related to the contrast of particle and fluid densities. Slurry needs to make a sharp turn in order to enter the perforation, and in particular it needs to slow down in the horizontal direction. Due to higher mass density, particles are unable to completely stop before entering the perforation and, consequently, some of them miss the perforation. This mechanism always reduces the amount of particles that enter the perforation, but the degree of reduction depends on problem parameters. In view of these mechanisms, the presentation focuses on the degree of uniformity of proppant placement based on a recently developed proppant wellbore dynamics model. The latter model is calibrated against laboratory and field scale measurements and is able to accurately capture particle distribution between perforations. Equipped with the model, a field scale case consisting of 13 perforation clusters is considered for optimization. Three perforation designs are compared: original with 3 perforations phased 120 degrees,

the case in which orientation of each individual perforation is optimized, and the case when all perforations have the same orientation and its value is optimized. The goal of the aforementioned optimization procedure is to achieve a more uniform proppant distribution. Results are presented in the context of uncertainty of perforation diameter and phasing. It is found that the optimal perforation phasing leads to a significantly more uniform proppant distribution between perforations. The uncertainty of perforation phasing and diameter introduces a certain level of variation to the results, but this level is noticeably smaller compared to the improvement achieved by using the optimal perforation orientation.

Biography

Dr. Egor Dontsov currently works at ResFrac Corporation, where he focuses predominantly on simulator development. In particular, he recently improved hydraulic fracture propagation logic, while currently working on the problem related to dynamics of proppant in a wellbore. Previously, Egor worked at W. D. Von Gonten Laboratories and as an Assistant Professor at the University of Houston. He has over 50 peer-reviewed journal publications and over 20 conference papers, most of which are related to hydraulic fracture modeling and proppant transport.