Morphology of Simultaneously Propagating Hydraulic Fractures

Dr. Egor Dontsov, ResFrac Corporation

Thursday, January 13, 2022, 9 a.m. Central Time

Dr. Egor Dontsov, Chief Scientist, ResFrac Corporation, will speak on Thursday, January 13, 2022, at 9:00 a.m. Central Time.

The topic is “Morphology of Simultaneously Propagating Hydraulic Fractures.”

Abstract

Current hydraulic fracture designs rely heavily on inducing multiple cracks within each stage. Field scale hydraulic fracture simulations for such scenarios demonstrate that there are situations, in which fractures develop complex shapes, whereby each individual fracture has its own unique geometry that is very different from its neighbors. At the same time, for some other parameters, fracture morphology tends to be more regular and less complex, so that all the generated fractures are similar to each other. Several groups of researchers have observed such a behavior. The common finding is that high fluid viscosity and/or low fracture toughness lead to simpler morphology, while low viscosity and/or high toughness cause fractures to develop complex shapes. In this talk, the problem of fracture morphology is addressed from a somewhat simplified viewpoint, yet the one allowing to better understand the key parameters that affect the behavior. In particular, two problems are considered: propagation of multiple “radial” fractures, and propagation of multiple “constant height” fractures. The former case corresponds to the situation of inducing several hydraulic fractures in a homogeneous formation, while the latter reflects the case of having strong barriers above and below the well. Note that the shape of each individual fracture is not necessarily radial or constant height. The advantage of considering such simple cases lies in the fact that such problems feature a relatively small set of parameters and dimensional analysis can be used to reduce the number of parameters even further. Each of the considered geometries has a dimensionless parameter that controls the relative influence of fracture toughness and fluid viscosity. A series of numerical examples is presented to demonstrate that the fractures develop complex morphology when toughness dominates. At the same time,

when viscosity dominates, fractures have regular shapes. The primary advantage of using the dimensionless parameter lies in the fact that it is universal and applies for all rock formations, as well as can be used to analyze small scale laboratory experiments. It also shows that it is not only toughness or viscosity that influence the morphology, but other parameters play a role as well. To further expand the investigation, additional numerical examples are presented that focus on the effects of fracture spacing as well as on the orientation of principal stress relative to the direction of the well.

Biography

Dr. Egor Dontsov currently works at ResFrac Corporation, where he focuses predominantly on simulator development and in particular on improving hydraulic fracture propagation logic. Previously, Egor worked at W. D. Von Gonten Laboratories and as an Assistant Professor at the University of Houston. He has over 50 scientific peer-reviewed publications, most of which are in the area of hydraulic fracture and proppant transport modeling.