Live

Hydraulic Fracture Conductivity in Shale Formations – the Rock Matters

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Hydraulic fracture treatments are used in low permeability shale reservoirs in order to provide conductive pathways from the reservoir to the wellbore. The success of these treatments is highly reliant on the created fracture conductivity. Optimizing fracture designs to improve well performance requires knowledge of how fracture conductivity is affected by rock and proppant characteristics.

This study investigates the relationship between rock characteristics and laboratory measurements of propped and unpropped fracture conductivity of outcrop or core samples. Formations studied include the Eagle Ford, the Marcellus, the Bakken, and the Fayetteville shales. Triaxial compression tests were performed on core specimens in order to determine the Young's Modulus and Poisson's Ratio of the samples. Profilometer surface scans were also performed to characterize the fracture topography.

The results from this study show that the main factors affecting fracture conductivity are closure stress and proppant characteristics (concentration, size, and strength). For unpropped fractures, the fracture topography is the main factor in determining fracture conductivity. The topographical interaction of the two surfaces determines the fracture width. Higher Young's Modulus helps maintain fracture width by resisting deformation as closure stress increases compared with lower Young's Modulus. For propped fractures, the more influential factor in determining fracture conductivity is proppant characteristics (concentration, size, and strength). At a proppant monolayer placement, the major mechanism for conductivity loss is proppant embedment, leading to decreased fracture width. A higher Young's Modulus reduces the proppant embedment and better maintains fracture conductivity as closure stress increases. For a multilayer proppant pack concentration, the effect of rock characteristics is negligible compared to the effect of proppant pack characteristics.

Dr. A. Daniel Hill is Department Head, Professor and holder of the Stephen A. Holditch Department Head's Chair in Petroleum Engineering in the Harold Vance Department of Petroleum Engineering at Texas A&M University. Dr. Hill joined the Texas A&M faculty in 2004. Previously, he taught for twenty-two years at The University of Texas at Austin after spending five years in industry. He holds a B.S. degree from Texas A&M University and M.S. and Ph.D. degrees from The University of Texas at Austin, all in chemical engineering. He is the author of the Society of Petroleum Engineering (SPE) monograph, *Production Logging: Theoretical and Interpretive Elements,* co-author of the textbook, *Petroleum Production Systems*, 1st and 2nd editions, co-author of an SPE book*, Multilateral Wells*, and author of over 180 technical papers and five patents. He has been a Society of Petroleum Engineers (SPE) Distinguished Lecturer, has served on numerous SPE committees and was founding chairman of the Austin SPE Section. He was named a Distinguished Member of SPE in 1999, received the SPE Production and Operations

Award in 2008, was one of the first two recipients of the SPE Pipeline Award in 2012, received the SPE Gulf Coast Regional Distinguished Achievement Award for Petroleum Engineering Faulty in 2013, and received the SPE John Franklin Carll Award in 2014. He currently serves on the SPE Editorial Review Committee, the SPE Global Training Committee, and is a member of the SPE Board of Directors, where he serves as the first Director for Academia. Professor Hill is an expert in the areas of production engineering, well completions, well stimulation, production logging, and complex well performance (horizontal and multilateral wells), and has presented lectures and courses and consulted on these topics throughout the world.

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