2023 ARMA Future Leader Webinar Series

Every Two Weeks on Fridays 9-10 AM MT

20th lecture: December 15, 2023

Please reach out to shahrzad.roshankhah@utah.edu to get the Zoom meeting information.

Speaker: Andreas Michael

A Hybrid Data-Driven/Physics-Based Approach for Near-Wellbore Hydraulic Fracture Modeling

Optimal hydraulic fracture (HF) initiation and early-phase propagation results in minimal near-wellbore tortuosity, decreasing the likelihood of screenouts and maximizing the resultant well productivity. While most predictive models for the HF geometry produced in a treatment consider the far-field region, the near-well vicinity should be an integral part of a properly-engineered reservoir stimulation strategy. In this work, a novel hybrid data-driven/physics-based approach is elaborated for modeling HF initiation and early-phase propagation from perforated wells. A treatment-optimization scheme via oriented perforating is presented using the developed hybrid model, considering the orientation of the induced HF initiation (longitudinal or transverse with respect to a horizontal well) and the resultant formation breakdown pressure (FBP). Transverse HF initiation and early-phase propagation is ideal for wells drilled in low-permeability "tight" formations, while FBP minimization suppresses the overall on-site hydraulic horsepower requirements. The demonstrated optimization scheme is applied separately to the in-situ stress states of seven prolific shale plays from the U.S. and Argentina, suggesting oriented-perforating strategies that target the promotion of transverse HF initiation in two of these (Barnett and Marcellus), while suggesting oriented-perforating strategies that target FBP minimization in the remaining five (Bakken, Fayetteville, Haynesville, Niobrara, and Vaca Muerta). The effectiveness of oriented-perforating can potentially be compromised by fracturing fluid leakages around the casing's circumference, which hinders transverse HF initiation. The hybrid-modeling approach is also used to estimate fracture initiation pressure (FIP) values for the seven shale plays studied, indicating significant discrepancies with analytical expressions traditionally used to approximate these FIPs in modern HF computational simulations. This sets the basis for expanding this hybrid-modeling approach over a range of in-situ stress states, incorporating aggregate data-driven (numerically-derived) correction factors in order to compensate for inaccuracies in the analytical approximations, which comprise the physics-based core of the proposed hybrid model.

Biography:

Andreas Michael is an Assistant Professor of Petroleum Engineering at the University of North Dakota (UND), serving also as the faculty advisor of the local ARMA Student Chapter. His research interests include hydraulic-fracture-initiation modeling, underground-blowout prevention, wellbore integrity, improved oil recovery, and petroleum economics. At UND he teaches courses on geomechanics, drilling engineering, well completions, and advanced stimulation techniques. He previously was a Postdoctoral Research Fellow at Colorado School of Mines' Civil and Environmental Engineering Department, performing research on underground tunnels. A Greek Cypriot, Dr. Michael holds bachelor's and master's degrees from the University of Texas at Austin and a doctorate from Louisiana State University (LSU), all in petroleum engineering. His PhD dissertation on "Fluid-Driven Fracture Initiation from Oil and Gas Wells Considering Lifetime Stresses" received LSU's Distinguished Dissertation of the Year Award for STEM in 2020. He has authored 9 peer-reviewed journal articles (8 first-authored, 2 single-authored), 25 conference papers, and 18 magazine articles. He served as the 2020-2021 Managing Editor (de facto Editor-in-Chief) of The Way Ahead, the Society of Petroleum Engineers' (SPE) magazine for young professionals. In 2019, he captained LSU's SPE PetroBowl Championship-winning team and placed second in the SPE International Student Paper Contest, the next morning.