Ubiquity of the Sunset Solution and measuring C_L

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Anthony Peirce is a Professor in the Department of Mathematics at the University of British Columbia, Canada. His presentation will be at 9:00 Central Time on Thursday, December 12, 2024. The topic is **"Ubiquity of the Sunset Solution and measuring C_L."**

Abstract

Having established the asymptotic behaviour of a hydraulic fracture driven to recede by fluid leakoff to the permeable elastic medium [1], numerical experiments [2,3] pointed to the existence of a similarity solution that emerges in the last gasp as the hydraulic fracture approaches complete closure. A rigorous analysis [4] established that the origin of this so-called Sunset Solution was a fundamental decoupling of kinematics from dynamics, resulting in the reduction of the governing equations to a local kinematic condition between the fluid leak-off velocity and the rate of decrease of the fracture aperture. One of the main corollaries of this analytic work is that the kinematic-dynamic decupling establishes a direct link between the leakoff and the fracture aperture decline, which opens the possibility of estimating CL from laboratory or fields measurements of the declining fracture aperture.

This analytic work was initially restricted to plane strain and radially symmetric fractures. However, subsequent studies have established the emergence of the Sunset Solution for: PKN fractures [5]; fracture models in which leakoff induced closure is modeled by a minimum width constraint [6]; and models that involve fracture closure on leaking proppant for geometries that have significant symmetry-breaking changes to the fracture free boundary induced by jump discontinuities in the confining stress field [7] and the elastic moduli between sedimentary layers [8].

In this talk I will briefly outline the derivation of the Sunset Solution for plane strain, radial, and PKN geometries and provide an update on the compelling numerical evidence of its eventual emergence even in a wide range complex hydro-mechanical environments.

References

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Biography

Anthony Peirce is a Professor in the Department of Mathematics at the University of British Columbia, Canada. During his PhD work as a Fulbright Scholar at Princeton University, he pioneered work on the optimal control of quantum molecular systems. Prior to his PhD, he worked as an applied mathematician at the Chamber of Mines Research Laboratories in South Africa, where he investigated rock fracture processes. His research contributions in hydraulic fracture modeling, along with collaborators, include the development of: the Implicit Level Set Algorithm (ILSA), which enables the use of multiscale tip asymptotics to accurately represent the fracture width on a coarse mesh and locate the fracture free boundary; the EKF-ILSA code, which uses tiltmeter measurements to monitor the growth of hydraulic fractures in mines; a proppant model able to capture Poiseuille to Darcy flow and proppant packing; and an accurate technique to capture multiple elastic layers in the Planar3D Simulator using the Fourier Transform. He has published extensively on his research and has two US Patents. Further details are available on his website: www.math.ubc.ca/~peirce