Chemical Engineering Master's Defense

Shape Factors for Pseudo-Steady State Flow in Fractured Hydrocarbon Wells of Various Reservoir Geometries

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abstract

Pseudo-steady state (PSS) flow is an important time-dependent flow regime with constant-rate production during the late time region of a closed boundary hydrocarbon reservoir. The characterization of the PSS flow regime is key in describing the reservoir pressure distribution as well as the productivity index (PI) of the well. The PI describes the production potential of the well (i.e. in flowrate per unit pressure drop) and is often used in fracture optimization and production-rate decline analysis. For a fractured well with finite conductivity, the common method to determine the PSS solution is to perform time-consuming numerical simulations or to approximate the solution by using an expression from Prats et al. (1962) that contains an inaccurate assumption of infinite fracture conductivity. In 2016, Chen determined the exact analytical solution for PSS flow of a fully penetrated fractured vertical well with finite fracture conductivity for reservoirs of elliptical shape in terms of basic functions. Chen's solution correctly assumes finite fracture conductivity and does not require numerical simulation. The present work aimed to expand Chen's exact analytical solution to other commonly encountered reservoirs geometries including rectangular, rhomboid, and triangular by introducing respective shape factors to Chen's solution. The shape factors were generated from extensive computational modeling studies based on an identical drainage area assumption. The aforementioned shape factors were generated and characterized as functions for use in spreadsheet calculations as well as graphical format for quick in-field look-up use. The methodology of the shape factor generation lays the ground work for more extensive and specific shape factors to be produced for cases such non-concentric wells and other geometries.

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