New Solutions for Well-Test-Analysis Problems: Part 1-Analytical Considerations
(includes associated papers 28666 and 29213)

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Summary
Point-source solutions are derived in the Laplace-transform domain and an extensive library of solutions is documented to obtain pressure distributions and well responses for a wide variety of wellbore pressure distributions and well responses for a wide variety of wellbore configurations: partially penetrating vertical wells, horizontal wells, and fractured wells (complete or limited entry). Wells may be located in infinite or bounded systems (rectangular or circular reservoirs). Several combinations of closed and/or constant-pressure boundary conditions are considered at the vertical and lateral reservoir boundaries. These solutions may be used to examine homogeneous or naturally fractured reservoirs.

Introduction
In 1973, Gringarten and Ramey I considerably expanded our ability to solve problems of transient flow by exploring the use of source functions and the Newman product method. Their work provides an extensive and useful library of solutions. The utility of their solutions can be enhanced tremendously if the Laplace transforms of their solutions are available. The transformed solutions can also be used for history-matching purposes, with use of the Stehfest algorithm, and will make it easier to consider variable-rate conditions such as wellbore storage and constant-pressure production.

Our objectives are to present a suite of solutions in terms of the Laplace-transform variable and to demonstrate the utility of these solutions. The solutions we present are applicable to the naturally fractured reservoir conditions. Obtaining solutions in terms of the transform variable is only the first step in computing well responses. We address the computation aspects in Part 2.

Basic Solution of Governing Flow Equations

We consider the flow of a slightly compressible fluid in an infinite double-porosity medium commonly used to model the behavior of naturally fractured reservoirs. We use the model suggested by Warren and Roots to derive the basic differential equations. The solutions we obtain can also be applied to de Swaan-O’s model. We assume that flow in the medium results from the instantaneous withdrawal of fluids from a sphere of vanishingly small radius.
Some New Solutions to Solve Problems in Well Test Analysis: Part 1 - Analytical Considerations

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