Modeling the Nonlinear Oil-Water Two-Phase Flow Behavior for a Multiple-Fractured Horizontal Well in Triple Media Carbonate Reservoir

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Abstract. Carbonate reservoir is one of the important reservoir in the world. Because of the characteristics of carbonate reservoir, horizontal well and acid fracturing have become a key technology for efficiently developing carbonate reservoir. Establishing corresponding mathematical models and analyzing transient pressure behaviors of this type of well-reservoir configuration can provide a better understanding of fluid flow patterns in formation as well as estimations of important parameters. A mathematical model for a oil-water two-phase flow fractured horizontal well in triple media carbonate reservoir by conceptualizing vugs as spherical shapes is presented in this article. A semi-analytical solution is obtained in the Laplace domain by using source function theory, Laplace transformation and superposition principle. Analysis of transient pressure responses indicates that nine characteristic flow periods of fractured horizontal wells in triple media carbonate reservoir can be identified. Parametric analysis shows that water saturation of matrix, vug and fracture system and fracture half-length, fracture number and fracture spacing can significantly influence the transient pressure responses of fractured horizontal wells in triple media carbonate reservoir. The model presented in this article can be applied to obtain important parameters pertinent to reservoir or fracture by type curve matching and it can also provide useful information for optimizing fracture parameters.

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1 Introduction

Carbonate reservoirs have complex structures and challenged research community, such as petroleum engineers, geologists, fluid mechanics and water resource researches [6, 10, 23]. Each reservoir is composed of different combinations of matrix, fracture and vug systems and thus it has various properties of porosity, permeability and fluid transport behavior. The flow problem of fluids through a reservoir is a complicated inverse problem. Therefore, a task for researchers is to establish various test models for the industry to evaluate the properties of these reservoirs.