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Rigorous Modeling of Gas Transport in Nano-darcy Shale Porous Media under Extreme Pore Proximity and Elevated Pressure Conditions

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Extended Abstract

Rigorous shale reservoir porous media gas transport analysis is presented by considering extremely-tight interconnected pore geometry, gas storage in inorganic and organics, pore-proximity affected physics of gas properties and transport, and proper formulation issues (Civan, 2010, 2013, Civan et al., 2011).

The adsorbed-layer, fluid-behavior, and deviation from Darcy viscous flow during transport of gas through nano-Darcy permeability shale porous media, acting both as source and storage, are discussed in view of the real gas conditions (Devegowda et al., 2011, Hu et al., 2013, Michel et al, 2013, Zhang et al., 2013, Xiong et al., 2013). The capillary-orifice effect resulting in pore-throat pressure pulsation, effect of stress-sensitivity to drawdown, and quad-porosity upscaling organic/inorganic heterogeneity by single and dual media treatments are discussed (Hudson et al., 2012). The pore-size distribution effect of natural shale porous media is handled by fractal description and effective pore-size representation. The apparent permeability correction due to deviation from Darcy behavior is made for various gas transport regimes. Modeling of nano-Darcy transport by bundle of capillary tubes, leaky- tanks, and continuum approaches are illustrated by various examples. The outstanding advantages and disadvantages of these three modeling approaches are reviewed.

It is demonstrated that pore-proximity can actually induce faster gas transport but the overall effect depends on the pore-size distribution, the gas properties (density and viscosity) are different in different size pores because the critical temperature and pressure of the gas are modified differently in different size and shape pores, the alteration of the pore size is significant when an adsorbed-layer is formed (Zhang et al., 2013, Xiong et al., 2013). Further, the transport of gas is mainly affected by the pore-proximity alteration of the gas properties at elevated pressure conditions prevailing in subsurface shale gas reservoirs and therefore the Knudsen type diffusive transport which occurs under rarefied gas conditions is not applicable in shale reservoirs.

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