Non-Darcy displacement in linear composite and radial aquifer during CO_2 sequestration

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Abstract: This paper presents Buckley-Leverett type analytical solutions for non-Darcy displacement of two immiscible fluids in linear and radial composite porous media. High velocity or non-Darcy flow commonly occurs in the vicinity of the wellbore because of smaller flowing cross-sectional areas. However, the effect of such non-Darcy flow has been traditionally ignored. To examine the physical behaviour of multiphase immiscible fluids in non-Darcy displacement, an extended Buckley-Leverett type of solution is discussed. There exists a Buckley-Leverett type solution for describing non-Darcy displacement in a linear homogeneous reservoir. This work extends the solution to flow in linear and radial composite flow systems. We present several new Buckley-Leverett type analytical solutions for non-Darcy flow in more complicated flow geometries of linear and radial composite reservoirs, based on non-Darcy flow models of Forchheimer and Barree-Conway. As application examples, we use the analytical solutions to verify numerical simulation results as well as to discuss non-Darcy displacement behaviour. This theory of non-Darcy flow displacement is applied to evaluate the flow behaviour near wellbore areas during CO_2 sequestration. The results show how non-Darcy displacement during CO_2 injection in linear and radial composite systems is controlled not only by relative permeability, but also by non-Darcy coefficients, characteristic length, injection rates, as well as discontinuities in the saturation profile across the interfaces between adjacent composite flow domains. [Received: April 27, 2012; Accepted: April 29, 2013].

Keywords: non-Darcy flow; Buckley-Leverett; Forchheimer; Barree-Conway; CO_2 sequestration; composite formation.

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