An Analysis of the Interaction of Waterflood and Reservoir Heterogeneity

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Abstract

Reservoir performance predictions require at least three elements: (a) A description of the reservoir heterogeneity, (b) Representations of the reservoir recovery processes, and, (c) The calculation of the interaction of these processes with the reservoir heterogeneity.

We present an analysis for waterflood, in which we examine the interaction of the heterogeneity in permeability with the local variations in viscous pressure gradients imposed by the waterflood. For most field situations, these dynamic pressure gradients act to suppress the effects of the underlying heterogeneity. We provide a simple description of this suppression based upon the concept of frontal mobility ratio. This ratio may be calculated using analytic one dimensional Buckley-Leverett theory. The inverse of this ratio provides a rule of thumb that may be used to judge how much heterogeneity matters. Permeability contrasts that are less than this amount will be suppressed by the waterflood, while greater contrasts will impact the volumetric sweep efficiency of the waterflood. We have found this to be a very useful quantity when developing a facies description for a reservoir modeling project; it can guide the degree of splitting or grouping that is appropriate for a particular model. It also reminds us that the decision to split or to group is process dependent and does not depend solely upon the underlying geology.