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Effect of Fluid Viscosity on Correlation of Oil Recovery by Linear Counter-Current

Spontaneous Imbibition

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Abstract

Spontaneous imbibition can be the primary mechanism of oil recovery from matrix blocks in water-wet fractured reservoirs. Scaling of imbibition recovery data is of essential importance in predicting the rate of oil recovery from fractured reservoirs. The most widely used correlation function was developed by Zhang et al. (1996), in which a geometrical mean of the fluid viscosities was used to account for the variation in fluid viscosities. In this paper, the effect of fluid viscosity on the correlation of imbibition recovery data was studied. The correlated results showed that the geometrical mean of fluid viscosity in the correlation function could closely correlate the imbibition recovery curves for variation in fluid viscosity if the oil/water viscosity ratio is constant. However, the geometrical mean of fluid viscosity could only give close correlation of imbibition data for a limited range of viscosity ratios. The dimensionless time exhibits an increased trend with decreasing oil/water viscosity ratio; especially when the oil/water viscosity ratio is lower than 5. Based on the correlated results, a new correlation function was developed by modifying the viscosity term in Zhang et al. correlation function. It was validated that the new correlation function could closely correlate the calculated imbibition recovery data for variation in wide range of viscosity ratios. In addition, the correlation of experimental imbibition recovery data for variation in fluid viscosities was improved as well by use of the new correlation function to calculate the dimensionless time. However, the experimental dimensionless time seems to exhibit a slightly increased trend with the increase in oil/water viscosity ratio. The increased trend implied that there could be an implicit interaction between relative permeability and viscosity ratio.

Keywords: spontaneous imbibition; fluid viscosity; correlation function; viscosity term.

1 Introduction

The naturally fractured reservoirs account for a large proportion of world hydrocarbon reserves (Mirzaei-Paيمان and Masihi, 2013). In the fractured reservoirs, the low-permeability matrix blocks were surrounding by high-conductivity fractures (Cai et al., 2010; Chen and Mohanty, 2013). Spontaneous imbibition can be the primary mechanism for oil recovery from the matrix blocks in the fractured reservoirs (Standnes, 2009). Spontaneous imbibition is a complex process, which depends on many variables. Scaling of spontaneous imbibition recovery data (oil recovery versus

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