A Mathematical Model for Emulsion Mobilization and Its Effect on EOR during ASP Flooding

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Abstract

Large-scale pilot tests of alkali-surfactant-polymer (ASP) flooding in the Daqing Oilfield in China reveal that emulsification occurs during ASP flooding and displacement. The flow of emulsions in porous media **exhibits** high viscosity, well-behaved chemical stability, and apparent non-Newtonian flow features. The genesis and mobilization of emulsions in reservoirs are an important part of ASP flooding processes, and entrainment and capture of such emulsions in porous media are considered to be important for improving oil recovery by ASP flooding. However, there are few studies that attempt a quantitative description of emulsion mobilization in porous media. As a result, the physicochemical phenomena of emulsions are not included in the current numerical simulation of ASP flooding processes.

Based on our experimental studies and field tests, we conducted an in-depth analysis of displacement mechanisms, emulsification, and flow behavior of emulsions in porous media during ASP flooding processes. In this paper, we describe the development of a mathematical model to describe such physicochemical emulsion phenomena. This mathematical model incorporates the mechanisms governing the interaction between emulsion droplets and pore structures, including emulsion genesis criteria, correlation of emulsion viscosity and water content, and permeability reduction caused by droplet capture. The model is implemented into an existing chemical reservoir simulator for numerical modeling studies of ASP flooding that considers emulsification mechanism. Model formulation and results are validated by comparing model calculations with experimental data. Simulation results show that oil emulsification during ASP flooding has significant impact on, and could improve, *in situ* oil displacement efficiency. The proposed model can be used for understanding the effects of emulsions in ASP flooding in both laboratory studies and field applications.