Abstract

Unconventional resources play a crucial role in meeting the current global energy demand, however, production from these formations is challenging. The challenge mainly stems from either the extreme fluid properties, i.e. very large viscosity in the case of bitumen reservoirs (oil sands), or extreme rock properties, i.e. very low rock permeability for the tight oil (shale and tight sandstone). Primary production from unconventional reservoirs is very low which motivates testing and developing recovery strategies to improve the reservoir production. Micro/nanofluidic technologies have shown to be a promising tool to quantify the pore-scale recovery efficiency of different methods with a tight control over the operating conditions, i.e. pressure, temperature, and composition. In this work, we designed and developed two distinct micro/nanofluidic platforms to test some of the recovery methods for both bitumen and tight oil systems. Specifically, in the bitumen case, a micromodel was designed to examine the efficacy of steam-solvent injection with various pure solvents and industrial mixtures, as well as quantify the associated pore-scale phenomena. Similarly, in the tight oil case, a nanomodel platform was developed to study nitrogen and carbon dioxide injection methods and determine relevant pore-scale mechanisms. This work highlights the unique potential of microfluidic and nanofluidic methods in resolving the pore-scale behavior of enhanced oil recovery processes under relevant reservoir conditions.