Abstract

Injection of air to burn a part of the crude oil in a mature light oil reservoir has gained importance recently. The objective of this research is to simulate the process in a combustion tube, and validate the transport model for use in reservoir-scale. In the flow experiments, air was injected into the combustion tube, packed with reservoir solids and fluids. Extensive control of temperature ensured zero-gradient at the wall, as the combustion front progresses through the tube. Also, the compositions of various effluent phases, and the temperature and pressure along the bed were monitored with time. The transport mechanism involves multiphase flow through porous media, the phase equilibrium, and the thermal shock arising from combustion reaction that affects the properties of the fluids.

Progression of the thermal front through porous media due to the combined effect of conduction and convection has been simulated numerically. The dispersion of the thermal front is studied through dimensionless numbers. The introduction of oil and water phases resulted in relative movement of the phases, and a vaporization-condensation drive. The latter mechanism led to an accumulation, next to the condensation zone. The extent of accumulation for oil and water were significantly different. A lumped stoichiometry for high temperature oxidation was conceptualized from the flue gas analysis. A pseudo-component for the vaporizing part of the crude oil, and the fraction of bituminous remnant were identified from TBP analysis. An Arrhenius type rate expression was used to simulate the reactive thermal drive. The reaction parameters were optimized such that the combustion front is sustained at the temperature level, observed in the experiments.

Keywords: *Enhanced oil recovery, transport in porous media, conduction convection front, light oil thermal recovery oxidation, simulation of in situ combustion for light oil*