An Equation-of-State Compositional In-Situ Combustion Model: A Study of Phase Behavior Sensitivity

In order to facilitate the study of reactive-compositional porous media processes we develop a virtual kinetic cell (single-cell model) as well as a virtual combustion tube (one-dimensional model). Both models are fully compositional based on an equation of state. We employ the models to study phase behavior sensitivity for in situ combustion, a thermal oil recovery process. For the one-dimensional model we first study the sensitivity to numerical discretization errors and provide grid density guidelines for proper resolution of in situ combustion behavior. A critical condition for success of in situ combustion processes is the formation and sustained propagation of a high-temperature combustion front. Using the models developed, we study the impact of phase behavior on ignition/extinction dynamics as a function of the operating conditions. We show that when operating close to ignition/extinction branches, a change of phase behavior model will shift the system from a state of ignition to a state of extinction or vice versa. For both the rigorous equation of state based and a simplified, but commonly used, K-value-based phase behavior description we identify areas of operating conditions which lead to ignition. For a particular oil we show that the simplified approach overestimates the required air injection rate for sustained front propagation by 17% compared to the equation of state-based approach.
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