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Development of Streamline-based Heat Transport Model for Thermal Oil-recovery Simulation

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The streamline method was extended to thermal oil-recovery simulation by developing an appropriate heat transport model based on the streamline method for implemention into a thermal recovery simulator. The heat transport model consisted of convection from the flowing phases and diffusion terms of gravity, capillary force, and conduction. An operator splitting technique was applied to decouple the convective and diffusive parts for separate solution. The convective part, a non-linear one-dimensional hyperbolic equation, was solved by the implicit single-point upwind scheme along the streamlines. The diffusive part, a non-linear, mixed hyperbolic-parabolic equation modeling gravity, capillary force and conduction, was solved using finite-difference discretization over the three-dimensional grid. The pressures for defining streamlines were obtained by solving the fluid flow equations with a finite-difference Newton method considering the compressibility, depletion and capillary forces. Simulations of hot water-flooding in two-dimensional and three-dimensional heavy-oil reservoirs were conducted to verify the model. The simulation results were compared with those of a commercial thermal simulator, which demonstrated that the streamline approach is a viable alternative to conventional finite-difference methods for heat transport calculations within a thermal simulator.

Keywords: Heat transport, Streamline method, Operator splitting technique, Thermal simulator, Hot water flooding

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