Testing of New High-Order Finite Difference Methods for Solving the Convection-Diffusion Equation

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Abstract

Numerical simulation has become a common means of predicting performance of oil and gas reservoirs in the petroleum industry. It is also a time-consuming task due to the large dimension of the simulation grids and computing time required to complete a simulation job. Commercial software packages used in the petroleum reservoir simulation employ the first-order-accuracy finite difference method to solve the convection-diffusion equation. This method introduces numerical dispersion because of truncation error caused by neglecting higher-order terms in Taylorâ s expansion.

This study focused on providing solutions to the above problems. We developed and tested two new algorithms to speed up computation and minimize numerical dispersion. In this research, we have derived the second- and third-order accuracy finite difference formulations to solve the convection-diffusion equation and applied a counter-error mechanism to reduce numerical dispersion. The results indicated that the use of the second- and third-order accuracy finite difference formulations can speed up numerical simulations and retain a sharp displacing front controlled by the physical diffusion coefficient.

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