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Large scale simulation of oil recovery by gel-polymer flooding

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This article describes a hydrodynamic model of collaborative filtering of oil, water, surfactant and polymer in porous media for enhanced oil recovery, which takes into account the influence of temperature, polymer and surfactant concentration changes on water and oil viscosity. For the mathematical description of oil displacement process by polymer and surfactant injection in a porous medium, we used the balance equations for the oil and water phase, the transport equation of the polymer / surfactant / salt and heat transfer equation. Also, consider the change of permeability for an aqueous phase, depending on the polymer adsorption and residual resistance factor. Presented the numerical implementation for solving this problem and realized a high-performance hybrid parallelization using MPI and CUDA technology. The algorithm was tested on a mobile device Xiaomi MiPad with Nvidia Tegra K1 processor. The results of the numerical investigation on three-dimensional domain are presented and distributions of pressure, saturation, concentrations of polymer / surfactant / salt and temperature are determined. Visualization of simulation results are performed using the ray casting algorithm implemented using CUDA technology. With this method, it is real to draw large amount of data described by three-dimensional models containing up to several million polygons. The main results of numerical experiments were compared with laboratory research and calculations of the hydrodynamic simulator Eclipse.

Keywords: EOR, HPC, CUDA, hybrid parallelization