Geophysical Research Abstracts
Vol. 21, EGU2019-1753, 2019
EGU General Assembly 2019

An efficient numerical simulator based on embedded discrete fracture model for fractured karst carbonate reservoirs

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Fractured karst reservoir is a typical kind of carbonate reservoir, which have significant contributions for the world oil & gas reserves and productions. The key issue of numerical simulation for such reservoirs is how to model the 3D complex fracture and cavities. However, this is still a challenging for real fractured karst carbonate reservoirs. In this work, a hybrid model for simulating multiphase fluid flow in 3D complicated fractured karst reservoir is presented. In the hybrid model, an improved embedded discrete fracture model (EDFM) and a cavity model are proposed. The improved EDFM improves the discretization of fractures by using two sets of independent grids for the matrix and fracture systems, which promotes the modeling of 3D complex fracture in real geologic models (corner-point grids). The proposed cavity model simplifies the coupled porous and free flow by the assumption of multi-phase instantaneous gravity differentiation. We demonstrate the accuracy of the improved EDFM and the cavity model by comparing the results with the conventional EDFM and volume of fluid (VOF) method. Then based on the proposed hybrid model, an efficient numerical simulator is developed based on the integrated finite difference method. And then based on the typical outcrops of TAHE oilfields, three typical fracture-cavity unit models are designed to analyze their flow characteristics, which indicate the effect of fracture and cavity on the production performance. Finally, a real fractured karst carbonate reservoir model with 3D complicated fractures and cavities is simulated to demonstrate the applicability of the proposed model.
Keywords
Fractured karst carbonate reservoir; Improved embedded discrete fracture model; Cavity model; Numerical simulation; Integrated finite difference method.