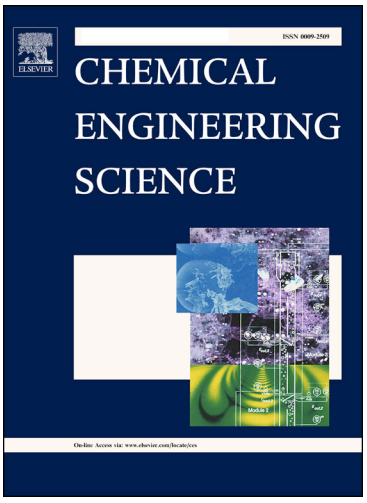

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Numerical modelling and analysis of reactive flow and wormhole formation in fractured carbonate rocks

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Abstract

Combining the two-scale continuum model and the discrete fracture network model, a continuum-based model is developed that calculates the reactive flow of acid in carbonate rock with a complex fracture network. The locations of fractures in the model are explicitly defined and the method can capture complex geometric relationships. The governing equations are discretized by the finite-volume method, where the diffusion term and convection term are discretized using the two-point flux approximation (TPFA) scheme and the upwind scheme, respectively. The physical domain is discretized by Delaunay triangulation. To keep the robustness and efficiency of the TPFA scheme, the optimization algorithm is used to move the centroid node of the control volume to improve the orthogonality of the grids. Numerical simulations of reactive flow in 2D fractured porous media, in cases with simple and complex fracture arrays, under linear and radial flow conditions, are presented. In particular, a sensitivity analysis of the dissolution process with respect to the presence of fractures, fracture aperture, fracture distribution, and acid injection rate, is conducted.

Keywords: Reactive flow; Wormhole; Acidization; Fractured carbonate rock; Discrete fracture; Finite volume method.

1. Introduction

Matrix acidizing is a common stimulation treatment for improving the flow characteristics of the near-wellbore region in carbonate reservoirs. It consists of injecting acid into the formation around some interval of the wellbore at pressures below the fracturing pressure. During the process, acid penetrates into the pores of the formation and dissolves some rock components such as cements or grains, and usually, if successful, creates wormholes, which