Modelling flow field in fractured porous media using an LBM-PNM coupling technique

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Abstract

The fluid flow in fractured porous media is an interesting topic with many relevant applications, such as water harvest in natural and synthetic materials, geothermal resource, hydraulic fracturing and enhanced oil recovery. However, modelling the interaction between a porous matrix and embedded fractures remains relatively unexplored since direct incorporation of pore-scale features into field-scale models is still a difficult task due to the complexity of fractured porous media. In this study, through combining the lattice Boltzmann method (LBM) and the pore-network method (PNM), we develop a novel numerical framework in which the LBM is used to solve the flow field within fractures while the PNM for the porous matrix. Due to different sets of governing equations employed in these two concurrent domains, an effective transport mechanism has been implemented to guarantee mass conservation and pressure continuity at the interface. The numerical model has been validated with available experimental observations, and a few typical examples were investigated using the proposed numerical scheme. The main advantage of this scheme is its capability to not only reflect pore-scale features but also maintain numerical high efficiency in large scale simulations of fractured porous media.

Keywords: lattice Boltzmann method; pore network modelling; fractured porous media; coupling technique.