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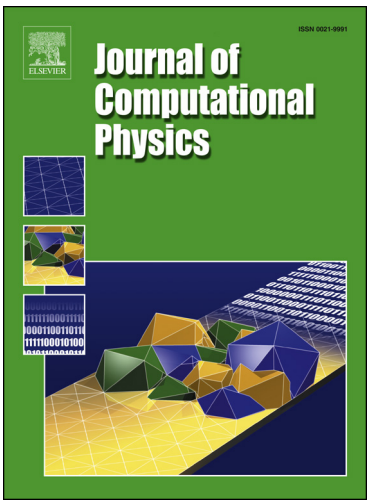

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Coupling compositional liquid gas Darcy and free gas flows at porous and free-flow domains interface

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Abstract

This paper proposes an efficient splitting algorithm to solve coupled liquid gas Darcy and free gas flows at the interface between a porous medium and a free-flow domain. This model is compared to the reduced model introduced in [6] using a 1D approximation of the gas free flow. For that purpose, the gas molar fraction diffusive flux at the interface in the free-flow domain is approximated by a two point flux approximation based on a low-frequency diagonal approximation of a Steklov-Poincaré type operator. The splitting algorithm and the reduced model are applied in particular to the modelling of the mass exchanges at the interface between the storage and the ventilation galleries in radioactive waste deposits.

Keywords: Coupling Darcy and free flows, reduced model, drying model, liquid gas Darcy flows, Navier-Stokes equations

1. Introduction

Flow and transport processes in domains composed of a porous medium and an adjacent free-flow region appear in a wide range of applications. It includes for example, industrial drying applications such as the production of building materials, food processing, and wood and paper production, or also, environmental applications such as land-atmospheric interaction and soil evaporation and evapotranspiration. In this article we will focus on the design of efficient algorithms to simulate the mass exchanges at the interface between the porous and free-flow regions, assuming a fixed temperature in the porous and free-flow domains. The effect of the vaporization on the temperature is neglected and will be considered in a future work. Typically in drying processes, the porous medium initially saturated with the liquid phase is dried by suction in the neighbourhood of the interface between the porous and free-flow domains. The gas phase penetrates the porous domain and the liquid phase is vaporized in the free-flow domain. In this work, our focus is not only on the drying of the porous medium but also on the evolution

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