InterPore2022

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Coal is not only a combustible sedimentary rock, but also a source rock for coal seam gas (CSG). It is typically a dual porosity medium, consisting of fractures and porous matrix. Gas flow in coal matrix is under concentration gradient, which is characterised by diffusivity. It is a controlling factor for both CSG production and the gas drainage process in coal mining industry. Therefore, experimental and modelling study of gas diffusion in coal is of great significance.
Common experimental methods to measure diffusion coefficient include particle method and courterdiffusion method. In this work, we apply the courterdiffusion method, as it can measure the bulk sample, while particle method requires the sample to be crushed into particles to eliminate fractures and mesopores. During the test, two gas chambers of 100% helium and 100% methane with the same pressures are connected to each side of a coal sample. Courter diffusion process is initiated due to the concentration difference. After different diffusion times, the gas concentrations of two gas chambers are measured. Applying Fick's fist law, diffusion coefficient can be calculated. In addition, the test is conducted using krypton gas and helium gas. Since krypton, similar as methane, has high X-ray attenuation values. So, under X-ray micro-CT imaging, the krypton diffusion process can be visualised, where coal matrix with different krypton concentrations will present different greyscale values in the micro-CT images. Gas diffusion in coal is then modelled by a multicomponent gas diffusion model with dual-continuum modelling approach.
In this work, time-dependant diffusion coefficients of bulk coal samples can be studied. The gas diffusion process is modelled and validated with micro-CT images. The obtained true diffusion coefficient can be applied to in a wide range of areas, such as CSG development, gas drainage design and greenhouse gas emission estimation in coal mining.

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Multiscale mixed domain decomposition methods for the simulation of heterogeneous black-oil flows

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Multiscale domain decomposition methods have proven to be a reliable way for solving single and two-phase flows in porous media. Among the advantages, the possibility to speed up the parallel simulation of huge domains with nearly ideal performance, is perhaps the most useful for applications in uncertainty quantification. However, in applications such as petroleum reservoir simulation, a more complex black-oil model is often required, which allows the simulation of three different components (water, oil and gas) that form at most three different phases (aqua, liquid and vapor), with possible mass transfer between phases. Among the multiscale domain decomposition methods employed in the solution of such models, are the MMMFEM 1 and MSFV [2].

In this work, we extend the Multiscale Robin Coupled Method (MRCM), a multiscale domain decomposition method recently introduced by the authors [3], for the solution of compressible heterogeneous black-oil model. The MRCM generalizes known mixed methods through the suitable choice of Robin-type boundary condition parameters and the finite element spaces used to span the interface unknowns, introducing flexibility and the possibility of adaptive schemes that greatly increase accuracy when compared to standard techniques. The hyperbolic conservation laws are handled by high order conservative finite volume schemes, while the parabolic pressure equation is discretized by implicit schemes, allowing the application of the domain decomposition method in each time step of the simulation.

We employ a number of test cases to evaluate the application of the MRCM for black-oil simulations, in homogeneous and heterogeneous media. The results show that the MRCM, combined with suitable downscaling techniques, can be successfully employed for the solution of black-oil flows, with good accuracy as compared to the solution of undecomposed cases.

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https://doi.org/10.1016/j.jcp.2017.11.002 **Time Block Preference**:

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Multiscale modelling of permeability and effective dispersion coefficient in porous media: a deep learning approach

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The modelling of transport in porous media is of great interest in many fields of application in chemical and environmental engineering, such as packed bed chemical reactors, underground transport of contaminants or carbon capture and storage. Flow and transport in porous media are a multiscale phenomenon, in fact, both microscale and macroscale affect the transport properties of interest. We