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# An investigation on the accuracy and simulation performance of permeability estimation from 3D pore-scale imaging based on the solution of the Laplace's equation

Wednesday, 2 June 2021 09:00 (1 hour)

#### Abstract

Permeability and its distribution play a major role in productive capacity of petroleum reservoirs and hence its prediction is crucial in predicting reservoir performance and determining well production rates. In recent years, the technology of digital rock physics has been introduced as a powerful tool to compute the petrophysical properties of porous materials based on 3D tomographic imaging [1-3]. A variety of methods have been proposed for pore-scale simulation of permeability, of which the most important are the lattice-Boltzmann method (LBM) [4], the classical computational fluid dynamics approaches [5, 6], and the Navier-Stokes solver based on the fast Fourier transform [7]. However, a few studies have focused on development of methods to estimate permeability in reduced computational cost particularly in comparison with the LBM [8-10]. In this study, we present a simple and fast method to calculate permeability of porous materials using 3D pore-scale images based on the solution of Laplace's equation for pressure. An in-house computer program is developed based on finite volume method to determine the distribution of pressure and velocity in voxelated pore space. We use the Euclidean distance map of the pore phase to assign local permeability and a simple upscaling scheme was employed to estimate the permeability tensor. The method was first applied to a range of simple digitized porous media including idealized channels of elementary cross sections, Boolean models of spherical grains, and bundles of capillary tubes and the estimated permeability was then compared to the analytical solutions of idealized microstructure. Next, a new developed solver was used to estimate permeability of digital rocks obtained from µ-CT imaging. At the end, the estimated permeability and digitally-computed permeability values were compared using both the Stokes solver and the lattice-Boltzmann methods. Finally, the proposed permeability solver was revealed to be suitable for quick estimation of permeability and rough evaluation of heterogeneity/anisotropy based on µ-CT images of rock samples, particularly for large datasets with high number of pore voxels.

Keywords: Digital rock physics; Pore-scale imaging; Permeability; Laplace equation; Finite volume; Euclidean distance

### **Time Block Preference**

Time Block A (09:00-12:00 CET)

#### References

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