

Flow and transport in single fracture with roughness.

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Fracture flow may dominate in rocks with low porosity and it can accompany both industrial and natural processes. Typical examples of such processes are natural flows in crystalline rocks and industrial flows in geothermal systems or hydraulic fracturing. Fracture flow provides an important mechanism for transporting mass and energy. For example, geothermal energy is primarily transported by the flow of the heated water or steam rather than by the thermal diffusion. The geometry of the fracture network and the distribution of the mean apertures of individual fractures are the key parameters with regard to the fracture network transmissivity. Transport in fractures can occur through the combination of advection and diffusion processes like in the case of dissolved chemical components. The local distribution of the fracture aperture may play an important role for both flow and transport processes.

In this work, we compare numerical solution for flow and transport processes in a single fracture in 2D and 3D. Fracture aperture distributions are generated by random correlated field method. We examine a single-phase flow of an incompressible viscous Newtonian fluid in the low Reynolds number limit. The velocity field is found using the Stokes equations with periodic boundary condition and a gravity force is imposed in the background. We systematically compare the obtained velocity field to the results obtained by solving the Reynolds equation, where pressure difference is imposed in the background. This allows us to examine the impact of the aperture distribution on the permeability of the medium and the local velocity distribution for two different mathematical descriptions of the fracture flow. Furthermore, we analyse the impact of aperture distribution on the front characteristics.