Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Viscous pressure drop modulates the morphology of a network fractures activated by hydraulic stimulation[1] DONALD KOCH, MOHAMMED ALHASHIM, Smith School of Chemical and Biomolecular Engineering, Cornell University — Convective transport in low permeability rocks can be enhanced by injection of a fluid to activate pre-existing weak planes (fractures) above a critical fluid pressure given by Mohr's criterion. Using a discrete fracture network (DFN) simulation and complementary averaged equation solutions for a highly heterogeneous rock, we show that the morphology and average transport properties of a cluster of activated fractures depend on the ratio, F_N, between the standard deviation of the critical pressures and the viscous pressure drop across a fracture. When $F_N <<1$, the cluster is well connected, and a linear diffusion equation can be used to describe the cluster's growth. When $F_N >>R/l$ where R is the cluster radius and l is the fracture length, a fractal network is formed by an invasion percolation process. In the intermediate regime, $1<<F_N<<R/l$, percolation theory relates the porosity and permeability of the network to the local pressure and an averaged fluid transport equation with pressure-dependent properties describes the cluster growth on length scales much larger than lF_N. The theory is also applicable to the displacement of a wetting fluid by a more viscous non-wetting fluid in a permeable rock with the capillary number replacing F_N in the two-phase flow application.

[1]Supported by NSF 1803156

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Date submitted: 31 Jul 2020 Electronic form version 1.4