Geophysical Research Abstracts
Vol. 19, EGU2017-5599, 2017
EGU General Assembly 2017

Stokes – Brinkman model for flow in a propped fracture

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Hydraulic fracturing of rock formations creates new fractures and provokes opening of existing fractures around the borehole, increasing the exchange surface area between the borehole and surrounding low permeable rock matrix (for example: shale matrix). Proppant slurries are then pumped into the induced fractures to maintain their apertures once pressure in the well is released. Due to the high confining pressures the proppant grains can experience embedment into the rock matrix. Flow patterns in such propped fractures control transport processes and exchange surface between rock matrix and fractures.

We propose Stokes-Brinkman 2.5D model for flow in plain-walled fracture filled in by partial monolayer of propping agent under in situ conditions, where spherical proppant grains are approximated by cylindrical circular obstacles. The flow equations are discretized and solved on unstructured body-fitting triangular meshes by means of Finite Element Method. The proposed model is validated against analytical and 3D numerical solutions.

Results of systematic flow calculations are discussed in terms of effective fracture transmissivity as a function of proppant packing fraction, distribution and embedment ratio. Furthermore, obtained flow fields are used for passive markers transport simulations and the results are presented in terms of effective transport properties.