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Homogenization of Flow in Porous Media with Isolated Embedded Fractures

Tuesday, 1 June 2021 11:30 (15 minutes)

A model for homogenized flow in porous media with large inhomogeneities is presented. Classical homogenization relies on representative elementary volumes (REV) large enough that asymptotic macroscopic parameters, e.g. effective permeabilites, can be employed to describe the expected or mean behavior. In this way, Darcy's law, which describes the relationship between macroscopic pressure gradient and volumetric flow rate, was derived. In the presence of large features, however, the required REV size may reach the same order as the geometric reference scale of the problem, and thus effective permeabilities obtained from classical homogenization studies may be unsuited. This is in particular the case for reservoirs with isolated, highly conductive fractures. To see this, consider flow from left to right through a block of finite size. If the latter is small enough, such that some fractures are connected to both left and right boundaries, then the resulting flow will be larger for the same average pressure gradient than through a wider block. In this paper, a new sub-REV continuum model to describe this pre-asymptotic flow behavior is presented. The model relies on a nonlocal multi-media description based on coupled integral-differential equations. The only empirical information required for calibration is the effective permeability of an infinitely large domain, e.g. as obtained from classical homogenization. With a series of numerical studies and comparison with Monte Carlo reference data it is demonstrated that the devised sub-REV model accurately captures mean flow rates and pressure profiles for arbitrary domain sizes.

Time Block Preference

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

References

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