A Peridynamics Formulation of the Coupled Mechanics-Fluid Flow Problem

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Many applications, such as hydraulic fracturing, involve the injection of high pressure fluid to create cracks in porous elasto-plastic media. Earlier mathematical models assume the propagation of a single planar crack. However, it is increasingly recognized that multiple, non-planar cracks form in many instances. When we attempt to model such fractures using classical continuum mechanics formulations, we encounter well known problems such as singularities at the crack tip and defining spatial derivatives at the crack boundaries. We propose a new non-local Peridynamics formulation that includes the fluid pressure distribution in the porous media and couple it with the non-local formulation of solid mechanics to predict the initiation and propagation of flow induced damage in a reservoir. The nonlocal formulation is based on an integral equation implementation of the mass and momentum conservation principles. Results are presented for some classical benchmark problems such as the multiple point-source and sink problem.