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A Fluid-Structure Interaction model based on Peridynamics and Navier-Stokes equations for hydraulic fracture problems

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The interaction among fluid flows and solid structures is a complex nonlinear phenomenon important in a wide range of scientific and engineering contexts. Nevertheless, simple analytical solutions of the governing equations are usually not possible and critical difficulties arise also numerically attacking the problem. Different methodologies can be found in archival literature to approach fluid-structure interaction (FSI) problems [1]. Within the class of FSI problems, a particularly challenging matter deals with the reproduction of the dynamics of solid media fracture due to the action of hydrodynamic forces, i.e. the hydraulic fracture. An example consists in the fracking process, adopted to extract gas from shale rocks. In this context, the present work aims to investigate the capabilities of a novel numerical method to reproduce solid fragmentation within fluid media. The proposed method is based on peridynamics equations coupled with Navier-Stokes equations through an Immersed Boundary Method (IBM). The main advantages introduced by peridynamics consist in the natural crack detection and the automatic tracking of crack propagation [2]. The proposed FSI method has been implemented into a parallel code. The temporal integration is performed by an explicit third-order Runge-Kutta algorithm; Navier-Stokes equations are discretized by second-order finite differences and coupled with the multidirect IBM algorithm to account fluid/solid force exchange [3]. Preliminary tests on simple configurations show the ability of the method to solve Fluid-Structure-Interaction problems with possible crack formations.

REFERENCES

[1] G. Hou, J. Wang, and A. Layton. Numerical methods for fluid-structure interactiona review. *Comm. Comput. Phys.*, 12(2):337–377, 2012.

[2] D. Dipasquale, M. Zaccariotto, and U. Galvanetto. Crack propagation with adaptive grid refinement in 2d peridynamics. *Int. J. Fract.*, 190(1-2):1–22, 2014.

[3] Ruth A Lambert, Francesco Picano, Wim-Paul Breugem, and Luca Brandt. Active suspensions in thin films: nutrient uptake and swimmer motion. *Journal of Fluid Mechanics*, 733:528–557, 2013.