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RBF-FD approximations based on polyharmonic splines basis with supplementary polynomials applied in a pore-scale problem

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The Radial Basis Function generated Finite Differential (RBF-FD) is a meshless method that has attracted attention in the last decades by its flexibility in the numerical approximation of PDEs, simplicity of computational implementation and ease in the approach of complex geometries. It has already been successfully applied to various engineering problems such as heat transfer, electrostatics, vibration, seismic modeling, and in particular, fluid dynamics problems [1, 2, 3, 4, 5]. In this way, o RBF-FD is a good candidate in a range of increasing applications of numerical simulations including seismic exploration of oil and gas, among others [6]. In this work, we present applications of RBF-FD with polyharmonic splines basis (PHS) with supplementary polynomials, RBF(PHS)-FD for short, in two benchmarks using the vorticity and stream-function formulation: i) problem of natural convection of air in a square cavity for some values of Rayleigh number; ii) problem of driven flow in a square cavity for several Reynolds number values. In both problems, we discretize the domain in uniform point clouds and non-uniform point cloud. Finally, after the validation of the benchmark results, the RBF (PHS) -FD is applied and discussed for a problem of flow of a fluid in the pore scale with a complex geometry. We will also add some comments about the use of multiscale meshless method for porous media transport problems.

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