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Regularized Stokes formulation has been shown to be very effective at modeling fluid-structure interactions when the fluid is highly viscous. However, its computational cost grows quadratically with the number of particles immersed in the fluid. We demonstrate how fast multipole method can be applied to significantly reduce the computational cost of regularized Stokes method. Numerical results will be presented for simulating the dynamics of a large number of microswimmers immersed in 3D stokes flows. Furthermore, we also investigate the swimming efficiency of the microswimmers when they are placed in various geometric configurations. (Received September 18, 2015)