Direct numerical simulation of colloid transport at the microscopic scale: influence of ionic strength in the presence of a rough surface

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ABSTRACT: The way colloids are transported, deposited or detached in porous media is of great importance in many practical problems such as filtration, environmental issues, petroleum engineering, … In this work, direct numerical simulations of the transport of a single particle near the fluid/solid interface have been performed. For this purpose, new routines have been implemented in a research code in order to take into account DLVO forces for smooth and rough pore surfaces. A dimensional analysis is performed, pointing out the important role of the ratio of electrostatic forces to the hydrodynamic forces on the particle behaviour. The test cases considered are chosen on the basis of experimental results presented in the literature. Transport of a particle near a solid surface is simulated for a given Reynolds number at different values of ionic strength and the influence of various surface roughness types are analysed. The simulations illustrate three different behaviours: (i) the particle is transported by the bulk fluid (ii) the particle is adsorbed and rolls on the solid surface (iii) the particle is adsorbed by the surface and is blocked. An analysis in terms of residence time is proposed. Simulations also show that an increase in the Reynolds number leads to the mobilisation of the particle in all cases studied.