Numerical and experimental studies on particle deposition mechanism in a cross-flow filtration system

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A detailed mechanism of particle deposition in a cross-flow filtration system is investigated by numerical simulation and experiment. Based on the microfluidic observation of microalgal particles in cross-flow operation, a novel particle simulation is developed which continuously updates the geometry of the simulation domain with the shape of existing particle deposits. Our simulation describes the particle deposition affected by the flow structure with relatively low computational costs. Four physical factors – effective collision, hydrodynamic boundary layer, inaccessible zone, and high shear stress region – are identified to play significant roles in the development of particle deposition. Most of the effective collisions are achieved within the hydrodynamic boundary layer to increase the number of deposited particles in the early stage of fouling. Inaccessible zone and high shear stress region are developed to decelerate the rate of particle deposition as large particle deposits are formed in the latter stage of fouling. It provides a fundamental understanding of fouling phenomena for the development of next-generation fouling-resistant filtration systems.