Control of small particle movement at a 90-degree corner with optimized energy consumption

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Abstract

Small particle transportation within fluid passing through a 90-degree corner is very common in many industrial processes. The angular change on the flowing direction arouses vortex at the corner and disturb particle movements. Especially to the small particles (diameter smaller than 10 μm), the unstable movement enhances the particle-wall interaction and effects of adhesion of particles on the wall. This paper presents a control strategy for small particle movement at a 90-degree corner, through a two-phase flow model enclosing a moving vortex with optimized energy consumption. For the proposed approach, a fluid-particle flow model is developed to simulate the small particle movement via the Eulerian-Lagrangian method. The continuous phase is modeled under potential flow theory and the boundary layer is approximated by Blasius similarity theory. The particle movement is simulated by particle-fluid and-wall interaction. A chaotic moving vortex is generated by changing the intensity of inlet flow and this vortex is used to control the particle behavior at the corner. The control strategies are then developed to optimize residual particle numbers at the corner with energy consumption by the orthogonal scheme. Finally, several guidelines of the control strategies are proposed practically to improve the particle accumulation at the corner with energy efficiency.

Keywords: 90-degree corner flow; Energy optimized control; Two-phase flow modeling; Eulerian-Lagrangian method; Rankine point vortex