2D Numerical Study Of The Velocity Profile In An Laminar Flow With Solid Particles On A Flat Plate

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Abstract

This article presents a two-dimensional numerical study of the velocity profile of an incompressible laminar flow with particles on a flat plate. The model was developed using COMSOL MULTYPHISICS 6.0 software. Various cases present varying parameters such as volumetric fraction of particles (p), relative particle size (Rsp) and Stokes number (Stk), entry velocity of particles (Vp), and particle entrance zone (H). This study focused on observing how these parameters affect the fluid flow profile velocity. The velocity profile of particle-laden flows was compared to the Blasius velocity profile (particle-free flow). The results show three zones, the first zone near the plate is an acceleration zone (when Vp=Vf) or deceleration zone (when Vp<Vf); a third zone away from the plate where no acceleration or deacceleration is produced; and a second zone that works as a transition to go from the affected zone to the non-affected zone. These particles interfere with the development of velocity profiles and increase proportionally with the volumetric fraction of particles (p), while it occurs inversely proportional to the relative particle size (Rsp). Increasing the Stokes number also generates variation in the flow. Additionally, it was found that the volume fraction of particles (p) and the relative particle size (Rsp) have a linear proportionality with the relative variation of the fluid velocity. For cases with low particle presence, the effects of the particle can be disregarded and considered the flow as particle-free flow, as well as for low Stokes numbers.

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