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The effect of wall geometry in particle-laden turbulent flow

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Particle-laden turbulent flow plays a significant role in various industrial applications, as turbulence alters the exchange of momentum and energy between particles and fluid flow. In wall-bounded flows, inhomogeneity in turbulent properties is the primary cause of turbophoresis that leads the particles toward the walls. Conversely, shear-induced lift force on the particles can become important if large scale vortical structures are present. The objective of this study is to understand the effects of geometry on fluid flows and consequently on particles transport and concentration. Direct numerical simulations combined with point particle Lagrangian tracking are performed for several geometries such as a pipe, channel, square duct, and squircle (rounded-corners duct). In non-circular ducts, anisotropic and inhomogeneous Reynolds stresses are the most influential phenomena that produce the secondary flows. It has been shown that these motions can have a significant impact on transporting momentum, vorticity, and energy from the core of the duct to the corners. The main focus of the present study is to explore the effects of near the wall structures and secondary flows on turbophoresis, lift, and particle concentration.

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