

Abstract

The irregular shape of particles in suspensions is typically approximated by simple geometries such as spheres or ellipsoids. We investigate the accuracy of such an approximation by comparing two irregular-shaped particles with different initial orientations against their equivalent spheroids in dilute volume fractions. Our results show that the average shear particle stress (and also intrinsic viscosity) of irregular particles can be 20 %–120 % higher than the maximum value of their geometric or kinematic equivalent spheroidal particles, and closer to spheroids with higher aspect ratios. We found that two geometric factors of an irregular shape, i.e., dimensionless surface-to-volume ratio and moment of inertia per unit volume (non-dimensionalized by the one-half the largest diameter of the particle), are correlated with the particle stress. In fact, the shear particle stress of a ring-shaped particle, which has a very large value of these factors, is five times larger than its equivalent spheroid. The correlation of these geometric factors with particle stress is further confirmed by considering two families of shapes (cylinder- and sphere-like particles). We also found that acceleration stress and especially Reynolds stress (stress mechanisms due to inertia) can have average values comparable to the stresslet term and effectively increase and decrease the absolute value of the first normal stress difference N_{1} and second normal stress difference N_{2} , respectively. However, their contribution to the shear particle stress is negligible. Our results pave the way to define better equivalent particles for irregular ones.