131c Conservation and Cartesian Methods

Jeremy N. Thornock and Philip J. Smith

We present a study on fundamental conservation issues when using a Cartesian CFD mesh with a Lagrangian geometry representation and discuss its impact on simulations of geometry-induced mixing with reaction. We use a staggered Cartesian mesh, which has useful numerical features without geometry, including natural conservation of mass and momentum when an exact pressure projection is used. The geometry is represented as a separate, Lagrangian entity embedded onto the Cartesian mesh. This representation allows the geometry to move freely across the Cartesian mesh and arbitrarily intersect structured, Cartesian grid cells. The presence of the boundary for intersected cells is handled by integrating along the sub-grid surface of the intersecting boundary. Momentum and mass source terms, arising from the boundary intersections, are added to the governing equations. The size of the intersected grid cells may or may not be altered for the presence of the solid.

We discuss the impact that the Cartesian method has on the conservation of mass, momentum, and kinetic energy. We show that mass and momentum are conserved locally and globally. However, kinetic energy is not conserved even though second order numerical operators are used (see Morinishi, JCP 1998). The lack of energy conservation arises from the geometrical representation and time integration scheme. We pay particular attention to the impact that conservation has on mixing tank simulations for low and high Reynolds number flows.