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Mass transfer in a flow past a non-porous catalyst sphere[1] BO SUN, SUDHEER TENNETI, SHANKAR SUBRAMANIAM, Iowa State University — Mass transfer in a flow past a particle with a surface chemical reaction occurs in applications involving catalytic reaction. This type of the mass transfer problem has been analyzed by solving the convection-diffusion equation for Stokes flow (Acrivos et al. 1962) or flow at low Reynolds number (Taylor 1963, Gupalo et al. 1972). The objective of this study is to extend our understanding of this mass transfer problem to higher Reynolds number (up to 100) and assemblies of several particles by using particle-resolved direct numerical simulation (PR-DNS) of gas-solid flow. A uniform flow past a non-porous spherical particle with a first-order surface reaction is simulated. The non-dimensional reaction rate constant is the important parameter in the single particle case. The PR-DNS results at low Reynolds number for a single particle are first compared with 2D analytical solutions for concentration fields and the Sherwood number. Finally, the dependence of the concentration field on the non-dimensional reaction rate constant, and comparison of PR-DNS results with other Sherwood number correlations that use the Reynolds analogy to adapt Nusselt number correlations (which do not explicitly account for surface reactions) are explored at high Reynolds number.

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