On the Advective-Diffusive Mass Transport of Gas Mixtures
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University of Alberta, DEPARTMENT OF MATHEMATICAL AND STATISTICAL SCIENCES, UNIVERSITY OF ALBERTA TEAM, ENERGY SYSTEMS DESIGN LABORATORY, DEPARTMENT OF MECHANICAL ENGINEERING, UNIVERSITY OF ALBERTA TEAM — Mass transport of gas mixtures often occurs in a variety of engineering applications, such as fuel cells and cooling towers. Classic approaches such as the advection-diffusion equation are limited to binary mixtures and diluted species in a mixture. Also, these theories have been shown to be unable to reproduce several phenomena occurring in capillaries or small pores [1], such as osmotic diffusion (i.e., diffusion without a concentration gradient), reverse diffusion (i.e., diffusion in the direction of a positive concentration gradient), and diffusion barrier (i.e., no diffusion with a concentration gradient). The limitations of these classic models stem from the fact that only a mass-averaged velocity field is considered. In this work, a new multicomponent mass transport model was developed based on the work of Kerkhof and Geboers [1]. This model considered the velocity of each individual species, as well as an individual momentum equation. The Stefan tube diffusion experiment was used to compare our model to the advection-diffusion equation. Partial viscosities and gradients of species velocities were identified as key parameters to overcome the limitations of the advection-diffusion equation. References: [1] P.J.A.M. Kerkhof and M.A.M. Geboers, AIChE J., 51(1):79-12

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