Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Separation Analysis in a High-Speed Rotating Cylinder for a Binary Gas Mixture SAHADEV PRADHAN, VISWANATHAN KUMARAN, Department of Chemical Engineering, Indian Institute of Science, Bangalore-560012, India — The solutions of the species balance equations linked with the generalized Onsager model for the secondary gas flow in a high-speed rotating cylinder are compared with the direct simulation Monte Carlo (DSMC) simulations for a binary gas mixture. The concentration fields are obtained three different types of driving mechanism. These are: (a) wall thermal forcing, (b) inflow/outflow of gas along the axis, and (c) momentum source/sink inside the flow domain, for the stratification parameter (A)in the range (0.707- 3.535), and Reynolds number (Re) in the range (10^2 - 10^6 with aspect ratio (length / diameter) = 2, 4, 8. Two different types of cases have been considered, (a) no mass difference ($\varepsilon_a = (2\ \Delta \mathrm{m}/(\mathrm{m}_1 + \mathrm{m}_2\ )) = 0$), and (b) with mass difference ($\varepsilon_a = 0.2$ and 0.5) while calculating the secondary flow field in the analytical solution. Here, the stratification prameter $\mathrm{A} = \sqrt{}((\mathrm{m}_{av}\Omega^2\ \mathrm{R}^2)/(2\ \mathrm{k}_B\ \mathrm{T}\ ))$, and the Reynolds number $\mathrm{Re} = \rho_w \Omega\ \mathrm{R}^2)/\mu$, where m is the molecular mass,Ω and R are the angular velocity and radius of the cylinder, ρ_w is the wall density, μ is the gas viscosity and T is the gas temperature. The comparison between numerical and analytical solution reveals that the boundary conditions in the numerical simulations and analytical model have to be matched with care. The commonly used "diffuse reflection" boundary conditions at the solid walls in DSMC simulations result in a non-zero slip velocity as well as a "temperature slip" (gas temperature at the wall is different from wall temperature).

Sahadev Pradhan
Department of Chemical Engineering,
Indian Institute of Science, Bangalore-560012, India

Date submitted: 12 Jun 2015 Electronic form version 1.4