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The generalized analytical model and DSMC simulations of high-speed rotating flow in polar $(r--\theta)$coordinate DR. SAHADEV PRADHAN, Department of Chemical Engineering, Indian Institute of Science, Bangalore- 560 012, India — The generalized analytical model for the radial boundary layer in a high-speed rotating cylinder is formulated for studying the gas flow field due to insertion of mass, momentum and energy into the rotating cylinder in the polar $(r-\theta)$ plane. The analytical solution includes the sixth order differential equation for the radial boundary layer at the cylindrical curved surface in terms of master potential (χ), which is derived from the equations of motion in a polar $(r-\theta)$ plane. The linearization approximation ((Pradhan & Kumaran*, J. Fluid Mech* -); (Kumaran & Pradhan, *J. Fluid Mech* -)) is used, where the equations of motion are truncated at linear order in the velocity and pressure disturbances to the base flow, which is a solid-body rotation. Additional assumptions in the analytical model include constant temperature in the base state (isothermal condition), and high Reynolds number, but there is no limitation on the stratification parameter. The analytical solutions are compared with direct simulation Monte Carlo (DSMC) simulations and found good agreement (with a difference of less than 10%), provided the boundary conditions are accurately incorporated in the analytical solution. The slow down of the circumferential velocity of the bulk of the rotating fluid due to the presence of stationary intake tube is studied for stratification parameter in the range 0.707−3.535, and found significant slow down (between 8 to 28%), which induces the secondary radial flow towards the axis, and it further excites the secondary axial flow, which could be very important for the centrifugal gas separation processes.

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