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USE OF THE PRESSURE JUMP BOUNDARY CONDITION IN THE HIGH SPEED RAREFIED GAS FLOWS

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The simulation of rarefied gas flow in hypersonic aerodynamics is important for the design of space and re-entry vehicles. Computer simulations can provide the necessary aerodynamic data at less cost and for cases where experiments are difficult to conduct. Therefore, there is a constant effort to develop newer numerical methods and to improve the existing ones based on appropriate physical modeling, so as to make the computer simulations closer to reality. CFD methods are preferred for rarefied flows in the continuum and slip flow regime. The range $0.001 \leq Kn \leq 0.01$ is called the slip regime, where the no-slip conditions are no longer applicable. The no-slip boundary conditions are replaced in this regime with slip velocity and temperature-jump boundary conditions.

Recently, in the literature for high-speed non-equilibrium gas flows a new type of Smoluchowski temperature jump condition considering the viscous heat generation due to sliding friction has been proposed as an alternative jump condition for the prediction of the surface gas temperature at solid interfaces [1]. The effect of the new jump condition on temperature and heat flux has been reported for various flow situations. However, the jump condition seems to adversely affect the prediction of surface pressure. We have proposed to correct the anomaly by using a previously published pressure jump condition [2]. We show by taking the case of rarefied gas flow over a flat plate, the benefits of the use of this pressure jump boundary condition with the new temperature jump condition. We also use the pressure jump condition with the standard Maxwell velocity slip and Smoluchowski temperature jump condition. The results are compared with both DSMC and experimental data.

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